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PURVIS I ACOUSTIC TESTS,(U)

JUN 66 S GARDNER NOBSR-93023

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INTERIM REPORT ON PURVIS I ACOUSTIC TESTS(U)

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INTERIM REPORT, ~~ON~~ PURVIS I ACOUSTIC TESTS, (U)

~~by~~

10 S. Gardner

11 Jun 66

12 1Ø8p.

~~Report No. 023-TM-66-19~~
~~Contract No.~~ NObsr-93023

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San Diego, California

14 TRG-Ø23-TM-66-19

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TABLE OF CONTENTS

LIST OF ILLUSTRATIONS

SECTION I

INTRODUCTION

The PURVIS I tests are part of the C/P (Conformal/Planar) Sonar Development Program being conducted under the direction of the U.S. Navy, Bureau of Ships. The program is managed by the Navy Electronics Laboratory (NEL), San Diego, California; and the David Taylor Model Basin (DTMB), Carderock, Maryland.

The sea test program is designed to provide information required for technical decisions on the C/P Sonar Program.

The destroyer USS HUGH PURVIS (DD-709) was instrumented for the PURVIS I series, and tests were conducted during February and March 1966 in the Tongue of the Ocean (TOTO). The water depth was in excess of 500 fathoms for all acoustic tests. A second series of tests, PURVIS II, will be conducted during the summer of 1966.

The purpose of this interim report is to provide some preliminary acoustic data from the PURVIS I tests. A final report will be issued when the data processing is completed.

Instrumentation installed aboard the PURVIS, and Data Conversion Center instrumentation have been described in separate reports [1,2]. For the sake of clarity we will provide in this report a summary of the instrumentation used for recording and data processing.

The basic shipboard system is illustrated in the block diagram shown in Figure 1-1. The Sea Trial Director is

located on the ship's bridge from where he directs the sea trial "runs". The Console Operator supervises operations in the Recording Center. He supervises all magnetic tape data recording, controls the bubble generator, the initiation of the"fish-eye" (motion picture) cameras and the lighting of the Index lamp to synchronize underwater photographs with recorded data. The hydrophones and accelerometers are located in and near Sea Chests 1, 2, and 3 and the Sonar Dome. The hydrophone and accelerometer signals and Ship's Motion Sensor signals, including a Sea State Buoy signal received over a VHF link, are transmitted to the Recording Center for recording on magnetic tape.

Figure 1-2 is a photograph of the shipboard recording center built by TRG Incorporated and installed on the PURVIS. This equipment provides up to 48 high-bandwidth (20 Khz) data channels of analog recording for acoustic data, and 12 low-bandwidth (1.25 Khz) analog data channels for recording of ship's motion data.Time data are recorded on the high-bandwidth tape with a 100 Khz time clock signal which permits location of data to within 10 microseconds. This feature makes possible the cross-correlation of data recorded on different tape recorders.

The Data Conversion Center at NEL includes playback instrumentation, processing equipment and analog-to-digital data conversion equipment. This equipment, which is shown in Figure 1-3, was installed by TRG for operation with the Univac 1230 computer maintained by NEL.

Transducers used for acoustic tests were located in the sonar dome (SQS-30), in sea chests along the hull, and mounted in the hull beneath the sea chests. The locations of transducers are shown in Figure 4. The different types of transducers used to obtain acoustic data are summarized in Figure 5. The hull mounted 5E aft of sea chest 3 was found to be inoperative. The locations of transducers within each of the three sea chests are shown in Figures 1-6, 1-7, and 1-8. The locations of the sea chests referenced to the forward perpendicular or zero frame position are shown in Figure 9.

DTMB furnished transducers and amplification up to a patch panel. GE transducers used in the second sea chest were manufactured and installed by GE. All hydrophones are stationary except for six of the GE hydrophones which are mounted on a movable bar which may be positioned from inside the ship[3]. Two of these hydrophones have dual (pair) outputs resulting in 8 data channels from movable hydrophones. The remaining GE hydrophone is non-movable and has a single output. Figure 1-10, is a schematic representation of the GE equipment.

Figure 1-11 is a block diagram of the shipboard recording facility. The heavy black lines show the flow of signals. Hydrophones and accelerometers with associated pre-amplifiers are located in or near the sea chests or sonar dome. Each hydrophone is equipped with a pre-amplifier. The FS-1 and the GE transducer use an Ithaco hydrophone pre-amplifier with 40 db gain. The AX-58s, 5Es, and DT55s each have their own vacuum tube type of pre-amplifiers, with approximate gains of 20 db, -5 db (in flat region of spectrum), and 20 db respectively.

Cables (TTRS-16) from the pre-amplifiers bring the signals to the bulkhead terminal strips in the recording center. Additional TTRS-16 cables connect the pre-amplifier outputs to a patch panel. This panel is used to select up to 48 of the 72 available signals for recording.

The signals from the pre-amplifiers selected for recording are patched to the input of the appropriate signal conditioning amplifiers (SCA). These amplifiers (Ithaco Model 256A) whiten the signals and provide adjustable gains in 1 db steps from 10 to 80 db. A front panel switch can set the low frequency 3 db point at 5 Hz, 1 KHz, or 10 KHz. Low-frequency gain drop-off is at a 6 db/octave rate.

The output of each SCA is connected via a BNC-T-connector to its record amplifier track and to a monitor scope. These scopes are used to adjust the gain settings of the SCA so that voltages to the tape recorder amplifiers are below saturation.

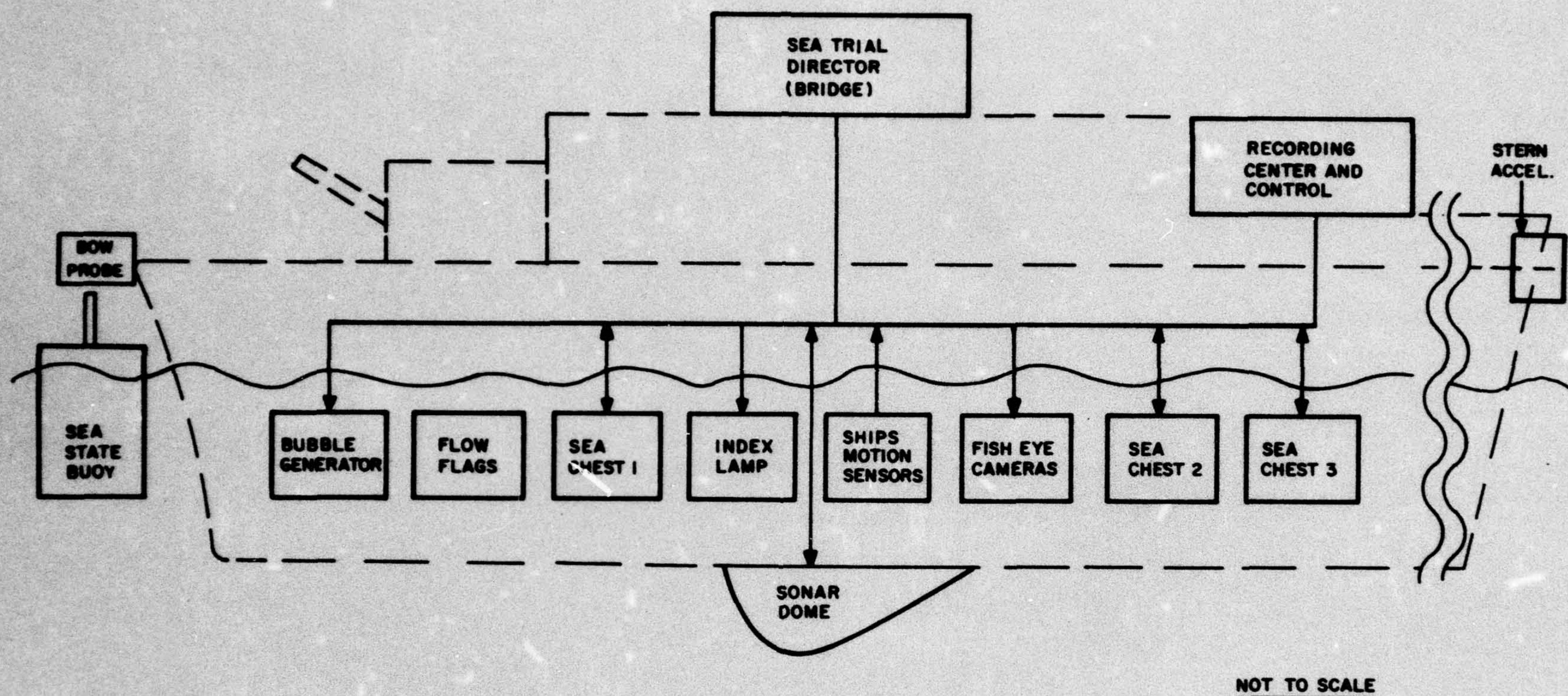

FIGURE 1-1. SHIPBOARD BLOCK DIAGRAM

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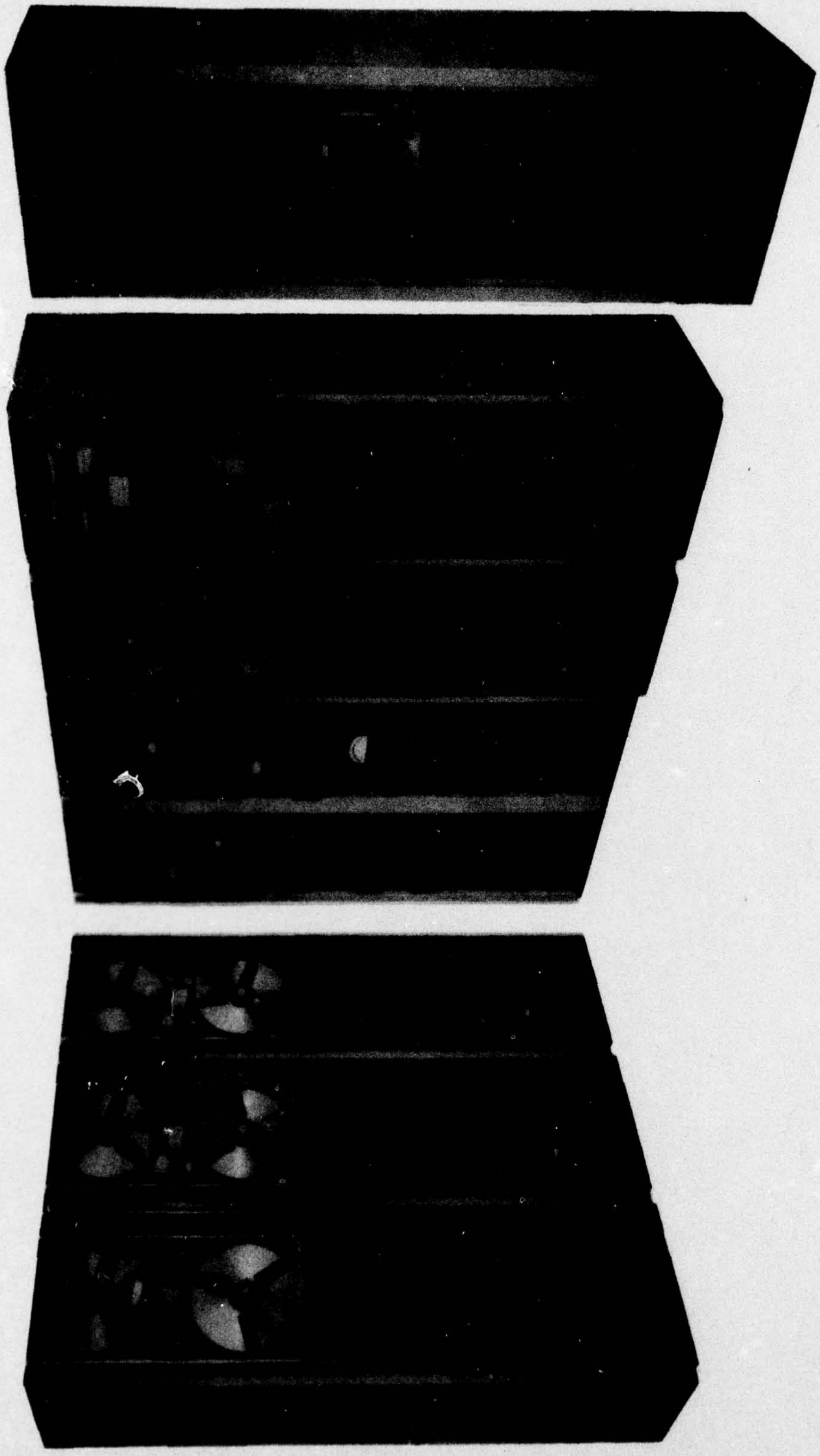

FIGURE 1-2

U.S. NAVY Bureau of Ships - C/P SONAR PROGRAM - SHIPBOARD RECORDING CENTER

TRG CONTROL DATA
MELVILLE, NEW YORK

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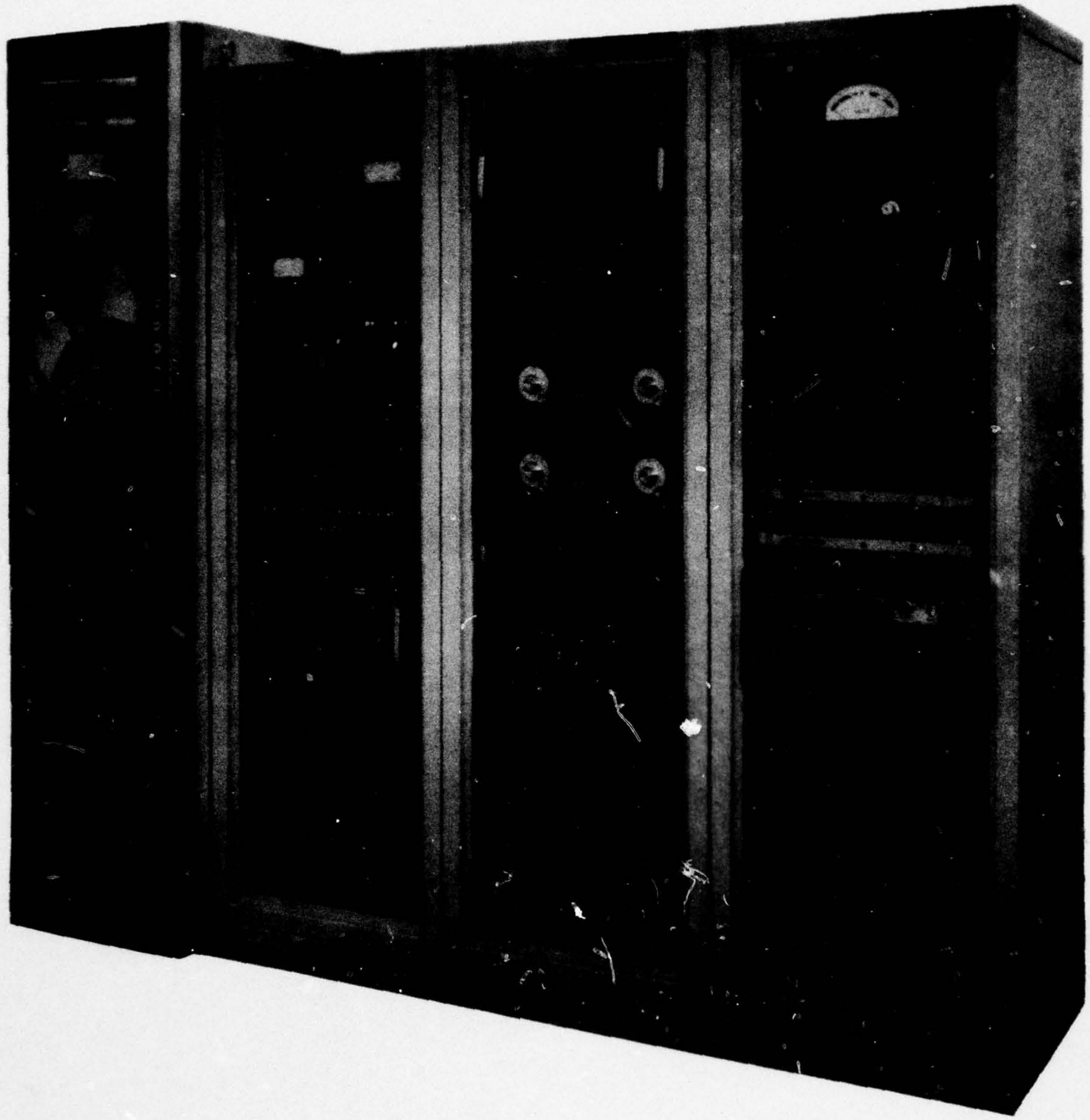

FIGURE 1-3

U. S. NAVY Bureau of Ships - C/P SONAR PROGRAM - DATA CONVERSION CENTER

TRG CONTROL DATA
MELVILLE, NEW YORK

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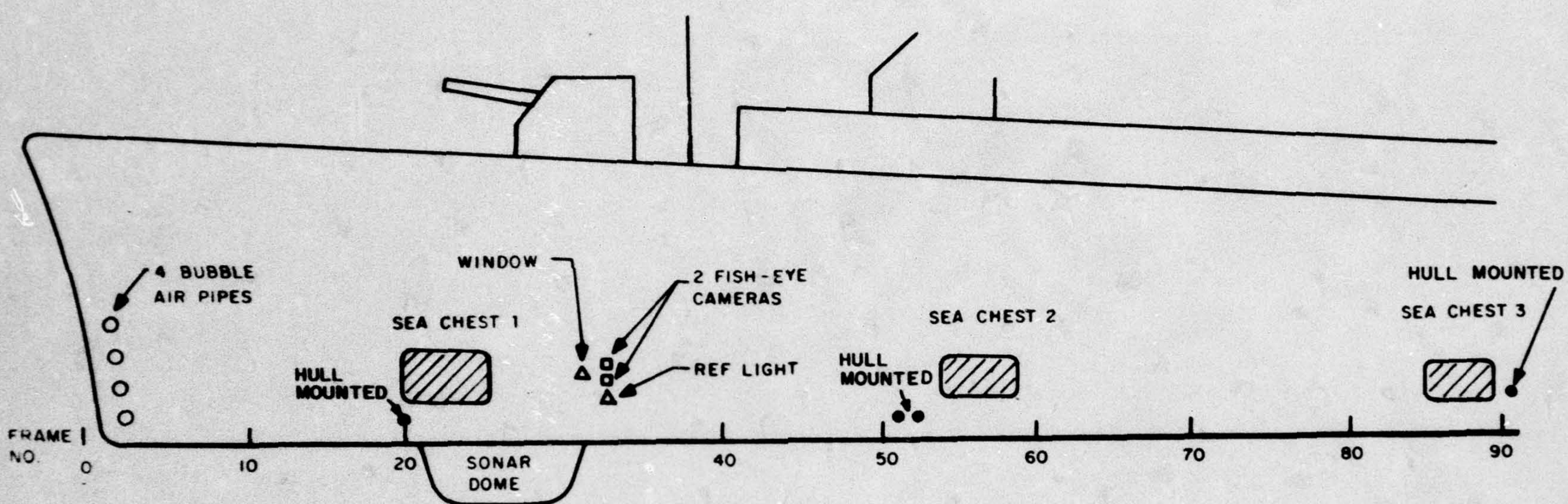


FIGURE 1-4. TRANSDUCER LOCATIONS (NOT TO SCALE)

	NOMENCLATURE	QUANTITY	DESCRIPTION OR COMMENTS
Sea Chest 1	AX58	1	Omnidirectional Hydrophone
	FS-1	13	1/8th inch dia. flush hydrophone. one is an accelerometer.
	5E(ser. no. 61)	1	3-inch diameter, flush mounted at FR21.
	Triaxial Accel.	3	Mounted near 5E Ser. No. 61 in hull at frame no. 21.
	TOTAL	18	Via 3 TTRS-16 Cables
Sea Chest 2	AX58	1	As in Sea Chest I
	FS-1	13	
	5E	2	Flush in hull at FR.48
	5E	5	Flush-mounted in sea chest
	GE SEHG1(L1 & L2)	4	2 mosaics, 2 outputs from each — Mounted on a movable bar.
	GE MOVE 1, 2, 3, 4	4	Single Elements — Mounted on a movable bar.
	GE STAT.	1	Mounted on fixed frame
	Triaxial Accel.	3	Mounted near 5E Ser No. 110
	TOTAL	33	Via 4 TTRS-16 Cables
Sea Chest 3	AX58	1	As in Sea Chest I
	FS-1	13	
	5E	1	On hull near frame 95 1/2
	TOTAL	15	Via 3 TTRS-16 Cables
Sonar Dome	DT55	3	Omnidirectional hydrophones
	Triaxial Accel	3	Near DT55 Ser No. 55
	TOTAL	6	Via Sonar Switch Room and Sea Chest 1 Cable
	Total High Speed Channels	72	

FIGURE 1-5. TRANSDUCERS FOR ACOUSTIC DATA

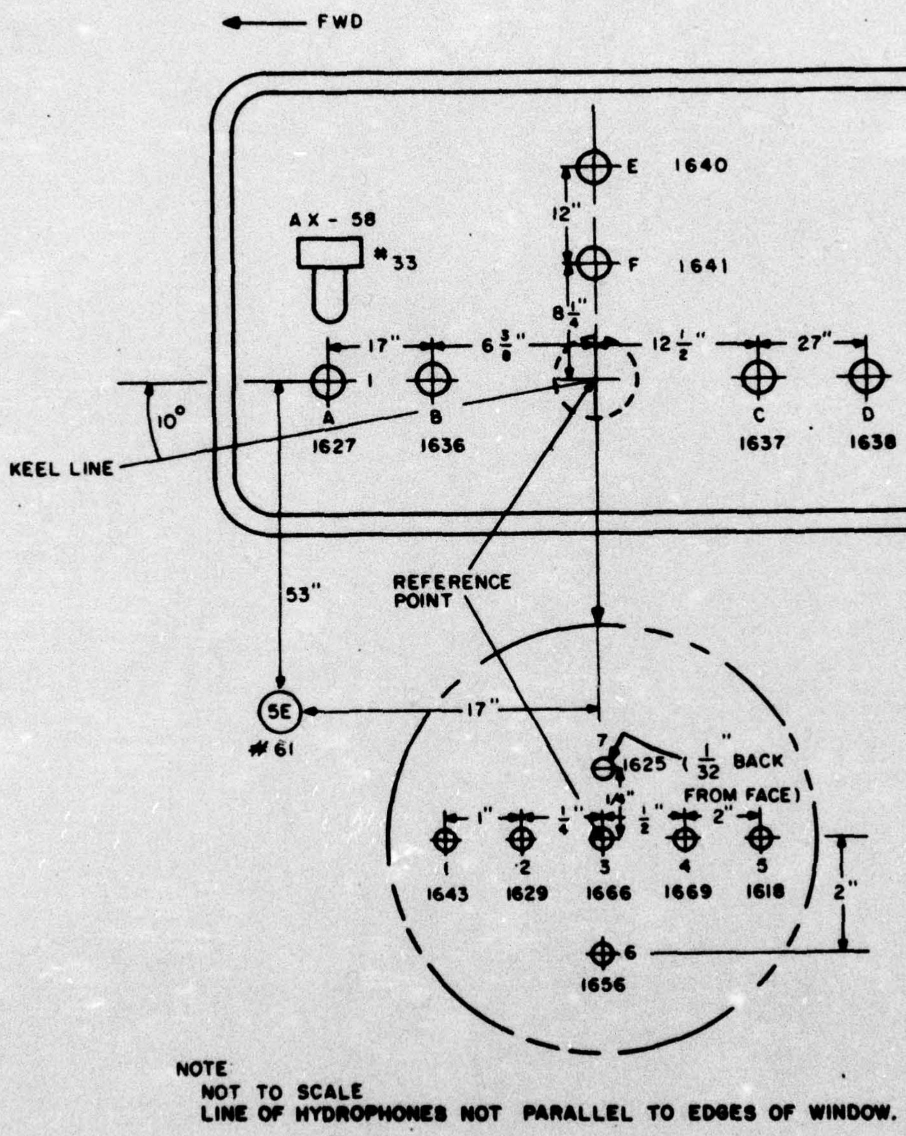
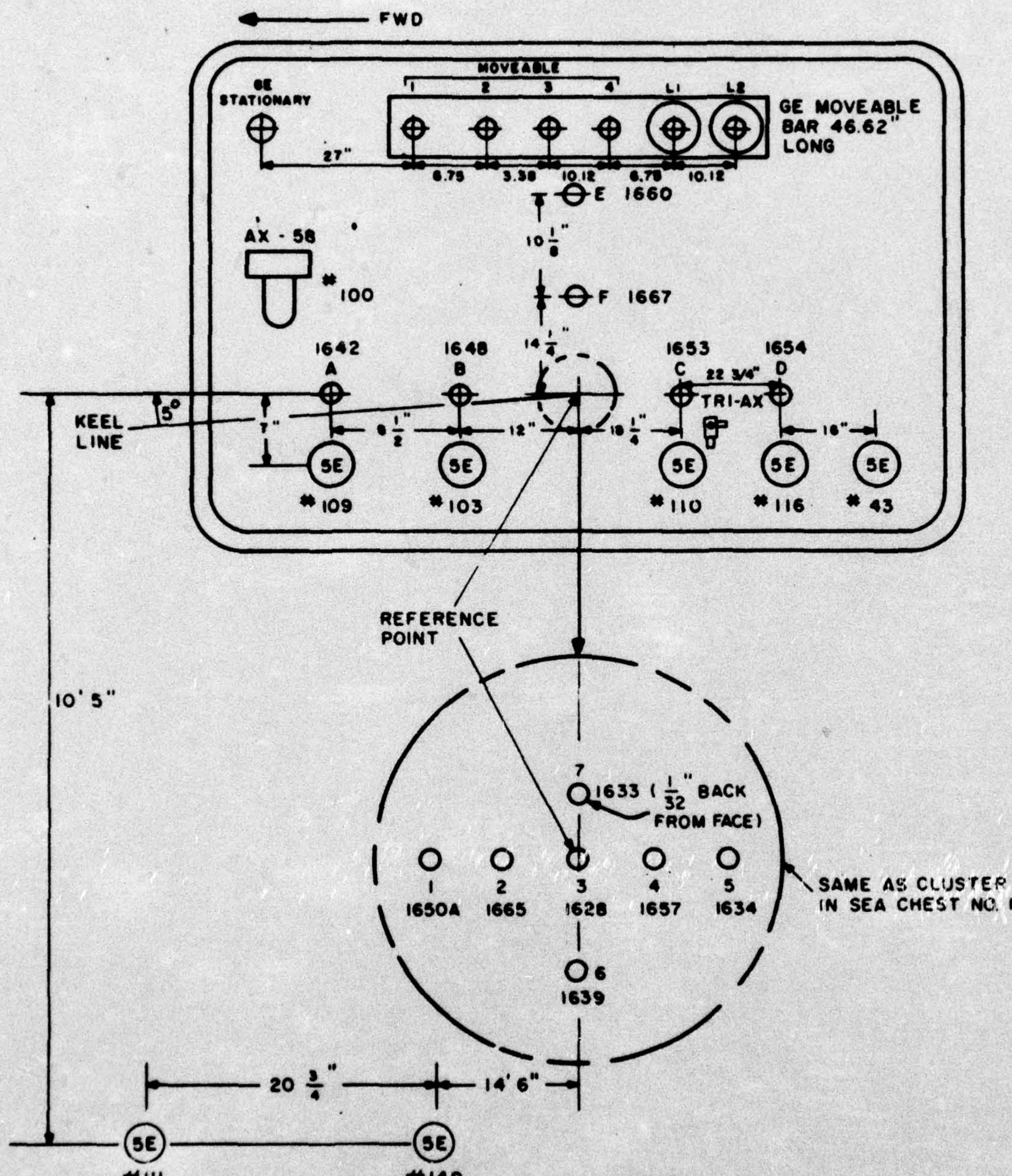
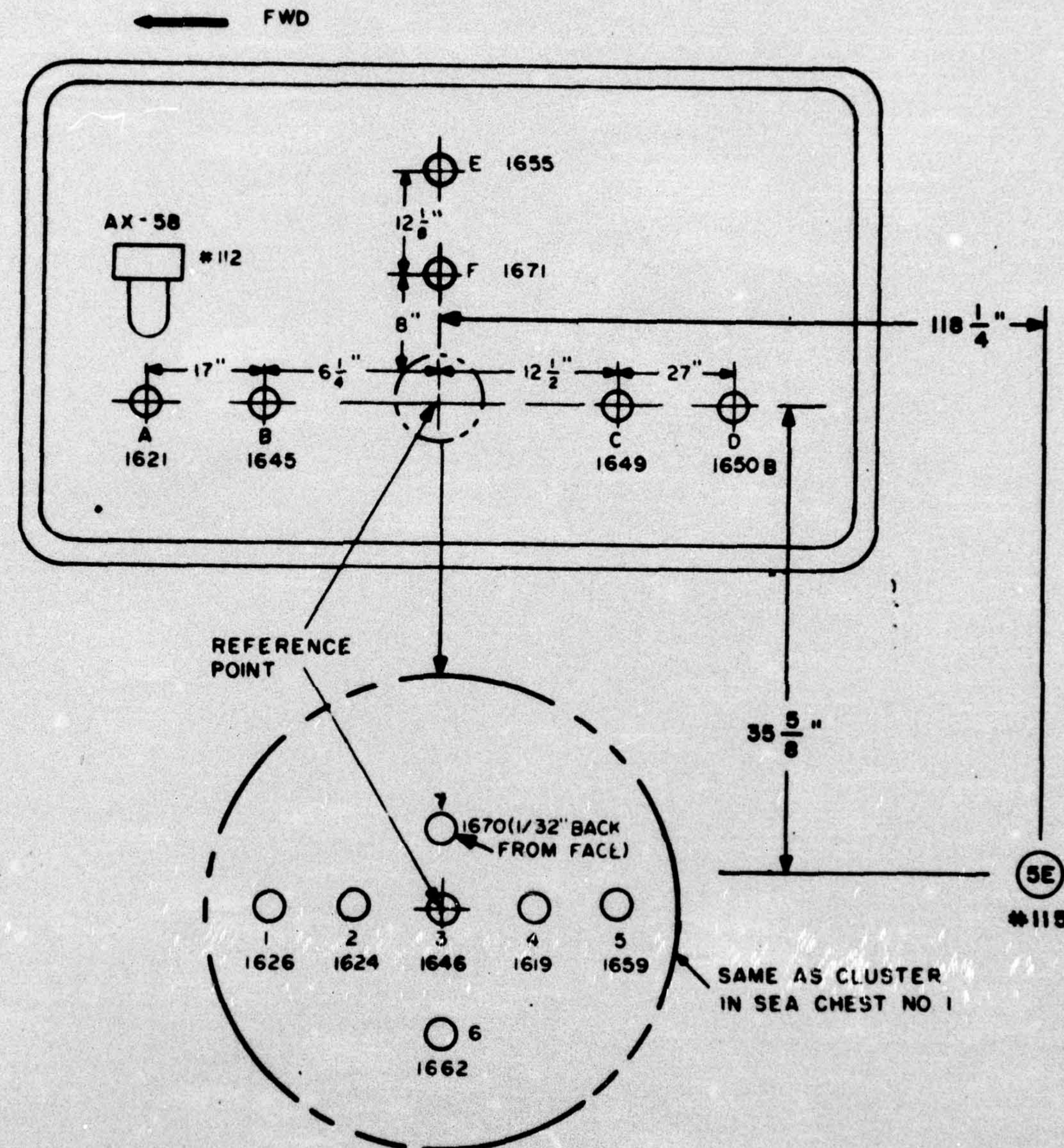


FIGURE 1-6. SEA CHEST No. 1, TRANSDUCER LOCATIONS



NOTE:
NOT TO SCALE
LINE OF HYDROPHONES NOT PARALLEL TO EDGES OF WINDOW.

FIGURE 1-7. SEA CHEST No. 2, TRANSDUCER LOCATIONS



NOTE
NOT TO SCALE

FIGURE 1-8. SEA CHEST No. 3, TRANSDUCER LOCATIONS

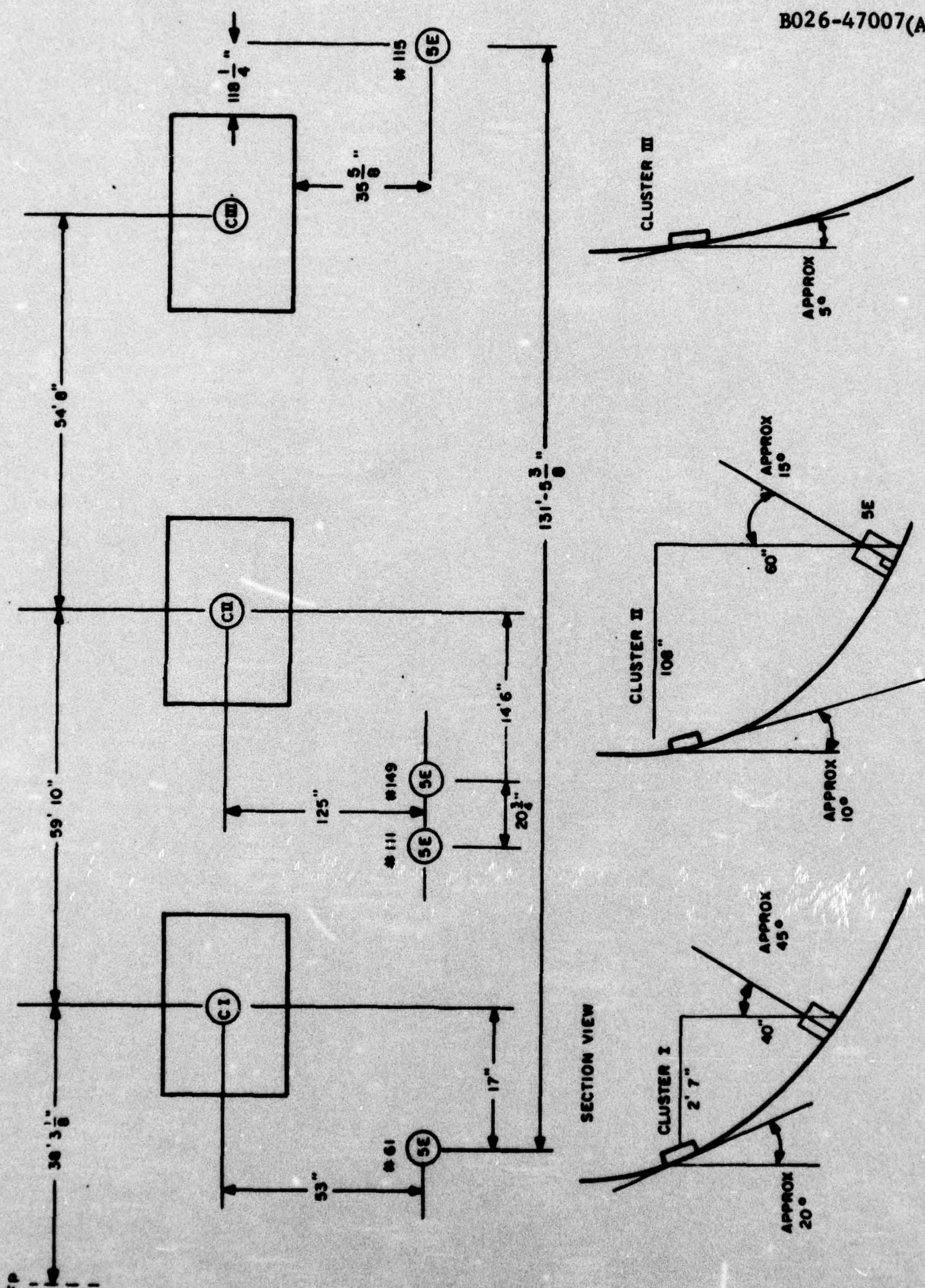


FIGURE 1-9. SEA CHEST LOCATIONS

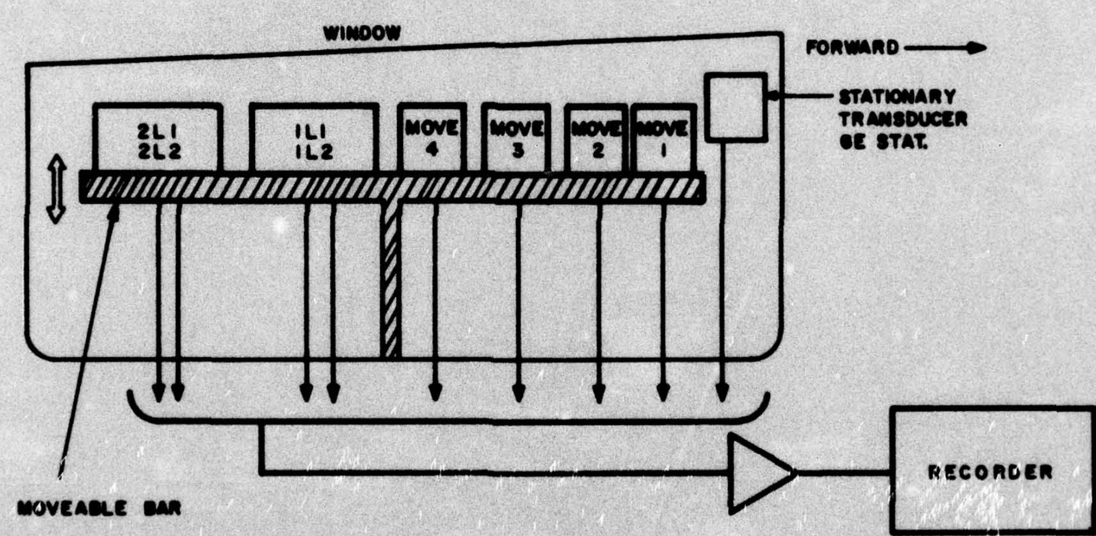


FIGURE 1-10. SCHEMATIC REPRESENTATION OF G.E. EQUIPMENT IN SEA CHEST II

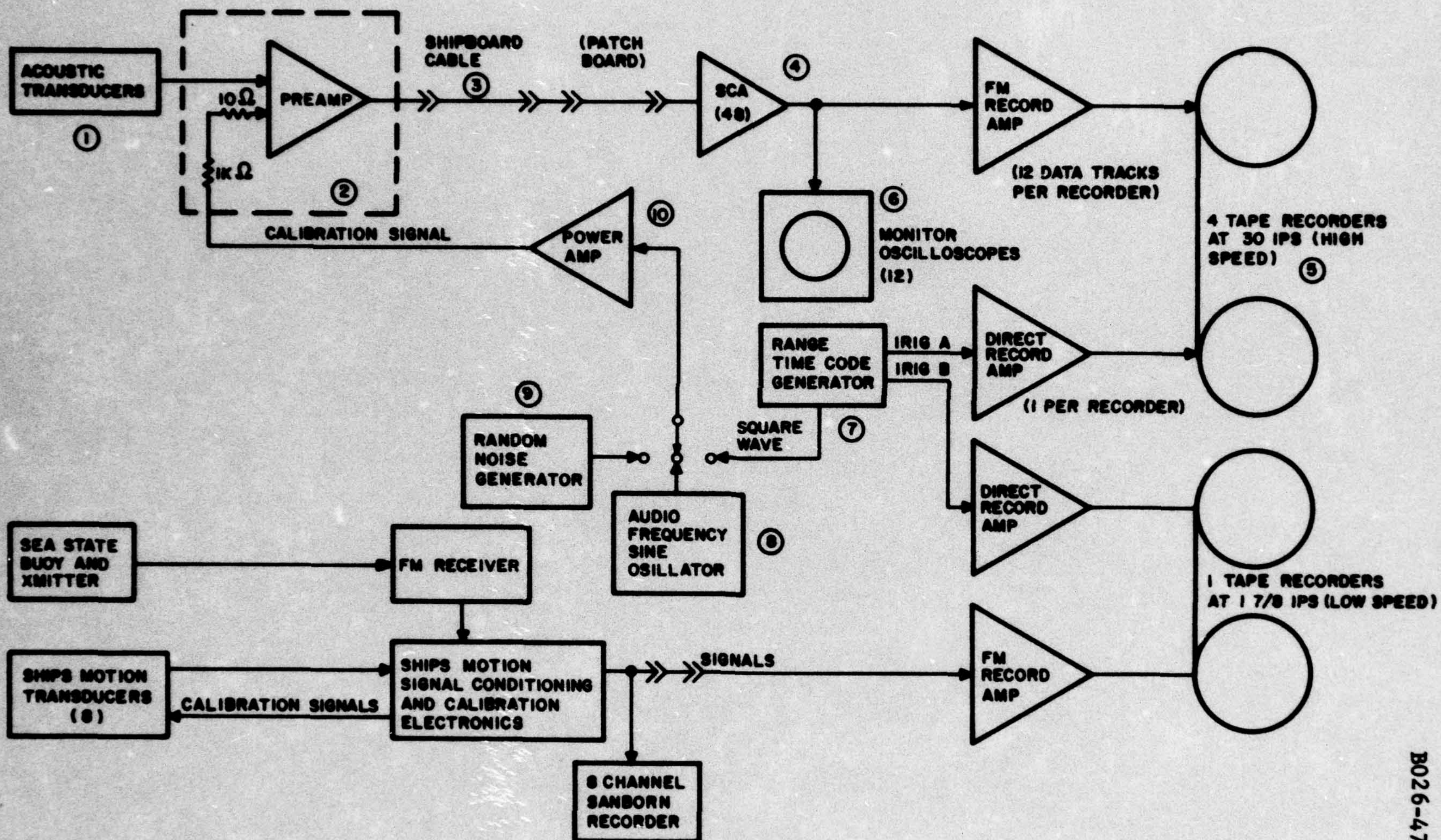


FIGURE 1-11. SIGNAL FLOW BLOCK DIAGRAM FOR SHIPBOARD DATA ACQUISITION AND RECORDING EQUIPMENT

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SECTION II
ACOUSTIC DATA

A. FREE FIELD AND IN-SITU CALIBRATION

Transducers to be used in the PURVIS I trials were free-field calibrated by DTMB prior to their installation on the PURVIS. Free-field acoustic calibrations of typical elements are shown in Figure 2-1 through 2-8.

In-situ calibrations were made aboard the PURVIS portside, and at a deep moor in TOTO. The calibrations were made by suspending a J-9 projector over the side at locations outboard of the approximate center of each sea chest. The projector was driven by a swept frequency signal which covered the band from 100 cps to 20 Kc. During an acoustic calibration, the outputs of all sensors in and near a sea chest were recorded. The calibration data were played back at the NEL Data Conversion Center through a GR wave analyzer used as a tracking filter. This arrangement provides a substantial improvement in signal-to-noise ratio.

The in-situ hydrophone sensitivity is calculated by means of the equation:

$$S = C - \sum G - S.L. + P - 60 \text{ db} \qquad (1)$$

where

S = hydrophone sensitivity in db ref 1 volt per μ bar

C = chart level reading in db ref 1 millivolt

$\sum G$ = sum of amplifier and wave analyzer gains in db

S.L. = projector source level in db ref 1 μ bar at 1 yd.

P = source-receiver propagation loss in db

The constant, -60 db, in Eq. (1) comes from the conversion between volts and millivolts.

The J-9 projector transmitting response curve is shown in Figure 2-9. Hydrophone sensitivity curves obtained by using Eq. (1) are plotted in Figure 2-10 through 2-18 for representative hydrophones.

The in-situ calibrations reveal variations with frequency which are not present in the free-field calibrations. These variations do not depend upon source position and are probably caused by standing waves.

B. NOISE SPECTRUM LEVELS

Noise spectrum levels for selected hydrophones have been computed using free-field sensitivity calibrations. The free-field sensitivity curves for the 5E, AX-58 and FS-1 hydrophones in the band below 5 KHz are sufficiently flat so that nominal sensitivity values independent of frequency may be used. Sensitivities were measured with pre-amps included. Sensitivities of -74, -81, -81 db ref. 1 volt per μbar were selected for the FS1, 5E, and AX-58 hydrophones respectively. For the GE hydrophones 1 KHz free-field calibrations were used to obtain reduced noise data.

Selected noise data recorded at sea were played back at the NEL Data Conversion Center into analog de-whitening circuits and a GR Wave Analyzer. Reduced noise spectrum levels were obtained by means of the following equation:

$$N = R - \Sigma G - S - 77 \text{ db} \qquad (2)$$

where

N = noise spectrum level in db ref 1 $\mu bar^2 sec$

R = recorder chart level reading in db ref. 1 millivolt

$\sum G$ = sum of amplifier and wave analyzer gains in db

S = hydrophone sensivity in db ref. 1 volt per μbar.

The factor of -77 db in Eq. (2) contains a -60 db correction from the conversion between volts and millivolts, and -17 db correction for the 50 Hz analyzer bandwidth.

The reduced noise spectrum levels are presented in Figures 2-19 through 2-78. Representative FS-1s in each sea chest, some of the 5Es in sea chest II, and the hull mounted 5Es were selected for preliminary analog analysis.

C. GE MOVABLE BAR EXPERIMENT

Considerable interest centers on the GE movable bar experiment which was designed to provide information regarding the characteristics of the noise field within the sea chest as a function of distance from the seaward face. In this report only preliminary results of the GE bar experiment are presented. These results consist of relative calibration signal levels, noise levels, and signal-to-noise ratios at different positions of the movable bar, at a speed of 20 knots.

GE elements mounted on the movable bar are shown schematically in Figure 1-10. The sea chest rear wall is not parallel with the fiberglass window of the chest. The sea chest and window frame have an out-of-parallel condition of one inch within the length of the array. This results in element No. 1 being 1-1/2 inches away from the window, in the extreme outboard

position, whereas elements 2L1, 2L2 are 1/2 inch away from the window. The total array travel is 10-1/2 inches.

During a noise run the bar was moved from the closest position (position 0) through five positions in equal steps. These positions were designated by number 2, 4, 6, 8, 10. These position numbers correspond roughly to the number of inches from the "0" position. The noise data presented is from run 406, a 20 knot run. The signal data is from run 928, an acoustic calibration run. GE transducers Move 1, 1L1, and 1L2 were selected for preliminary analysis. In Figures 2 - 79 through 2 - 93 are presented relative signal level at different bar positions, relative noise level, and signal to noise ratios for different bar positions at frequencies of 1, 2, 3, 4, and 5 Khz.

SECTION III

DISCUSSION

Data processing and analysis of the results of PURVIS 1 acoustic tests is in progress. A comprehensive analysis of the test results will be included in a final report. At this time it is possible to make only a few observations regarding the preliminary results.

At five knots, the noise spectrum levels for several types of hydrophones at different locations are of comparable magnitude. Flush mounted 5E-61, located below sea chest 1 and several of the GE hydrophones in sea chest 2 had the lowest noise spectrum levels at low speeds. The highest noise spectrum levels at low speeds were found in the FS-1 hydrophones located in sea chest 3. This is understandable in view of the proximity of sea chest 3 to the machinery spaces. It appears that at speeds of 5 knots and frequencies above 1 Kc, all hydrophones were responding to acoustic disturbances.

At high speeds, the situation changed considerably. At 20 knots all FS-1 hydrophones had roughly the same noise spectrum levels. It is likely that at frequencies below 3 Kc, the small FS-1 hydrophones are responding to pressure fluctuations produced by boundary layer turbulence.[4] The FS-1 hydrophones at 20 knots have higher noise spectrum levels than the larger hydrophones. This indicates that at high speeds the largest pressure fluctuations have small spatial scales.

The noise data obtained with FS-1 hydrophones located on sea chest 1 may be compared with measurements made with the same size hydrophones flush mounted on the submarine USS ALBACORE.[(5)] ALBACORE data at a speed of 20 knots taken at a distance of approximately 44 feet from the bow is shown in Figure 2-23. The ALBACORE noise levels at 1 Kc are about 10 db higher than the PURVIS data. This might be attributed

to a difference in boundary layer conditions, although both hydrophones are roughly the same distance from the bow.

Of the large hydrophones, at 20 knots, 5E-61 and the GE mosaics have the lowest noise spectrum levels.

The results to date of the GE movable bar experiment have not been analyzed on a statistical basis. Because of difficulties encountered with in-situ calibration of GE hydrophones in sea chest 2 it will be hard to extrapolate any moveable bar results to a practical sonar system.

Further analysis of the PURVIS I acoustic data is in progress. This analysis includes band limited cross-correlations, and computation of the magnitude and phase of the normalized cross-speed density for many hydrophone pairs. This information is expected to be of value in the determination of dominant noise sources.

REFERENCES

1. TRG Report No. 023-TM-66-17; Sea Trial Data Acquisition and Analysis Equipment; May 1966

2. TRG Report No. 023-TN-66-8; Data Conversion Center System Description; May 1966

3. GE Report No. C024-47004; Purvis I Equipment Description; Jan. 1966

4. Gardner, S., "On Surface Pressure Fluctuations Produced By Boundary Layer Turbulence", ACUSTICA, Vol. 16, 1965/66

5. Franz, G., "Turbulent Boundary-Layer Pressure Fluctuations on the Bow Dome and Superstructure of the USS ALBACORE (AGSS569)", U.S.N. Journal of Underwater Acoustics, Vol. 12 No. 1, January, 1962 (CONFIDENTIAL)

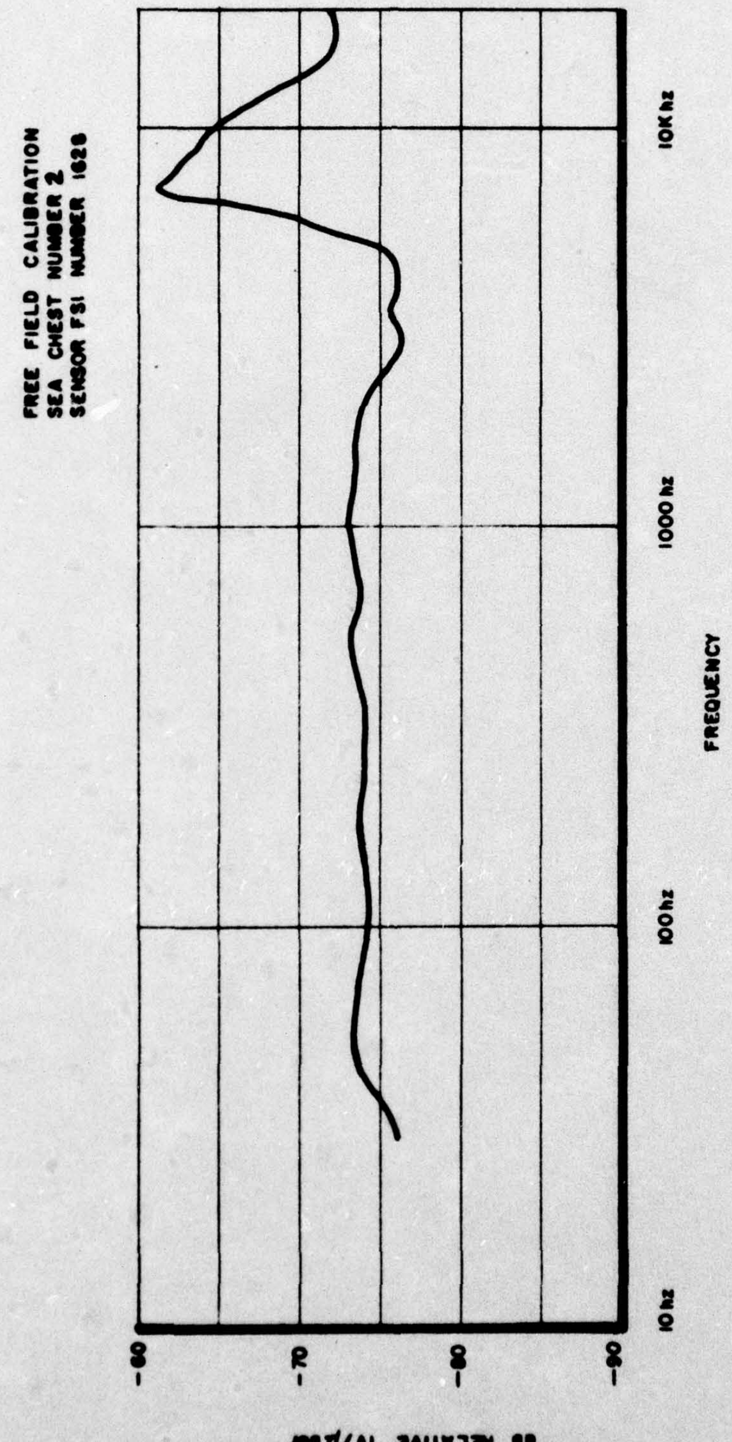

FREE FIELD CALIBRATION
SEA CHEST NUMBER 2
SENSOR FSI NUMBER 1628
10hz
100hz
1000hz
10Khz
FREQUENCY
-60
-70
-80
-90
dB RELATIVE 1V/μbar

FIGURE 2-1

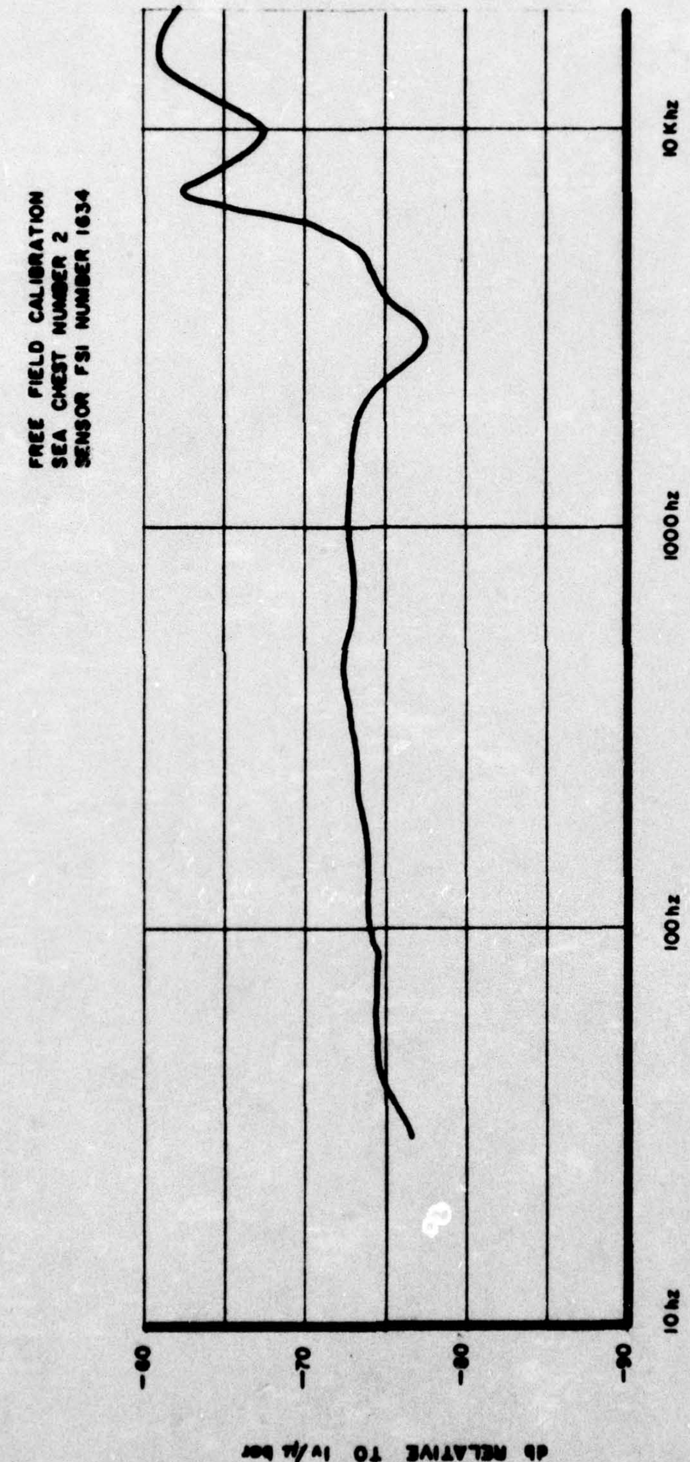

FREE FIELD CALIBRATION
SEA CHEST NUMBER 2
SENSOR FSI NUMBER 1634
10 KHz
1000 hz
100 hz
10 hz
FREQUENCY
-60
-70
-80
-90
db RELATIVE TO 1v/µ bar

FIGURE 2-2

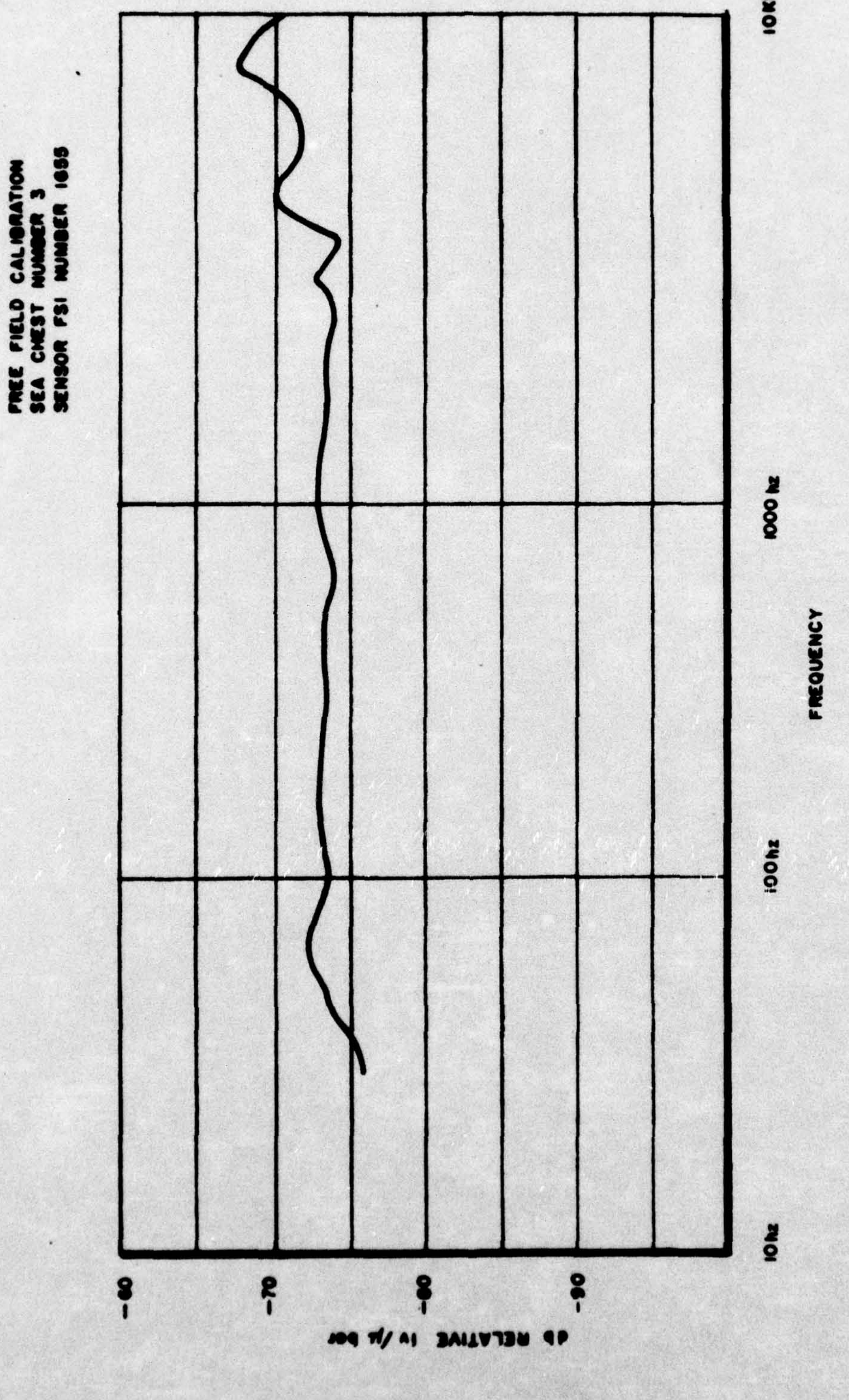

FREE FIELD CALIBRATION
SEA CHEST NUMBER 3
SENSOR FSI NUMBER 1655
10Khz
1000 hz
100hz
10hz
FREQUENCY
-70
-80
-90
dB RELATIVE 1v /μ bar

FIGURE 2-3

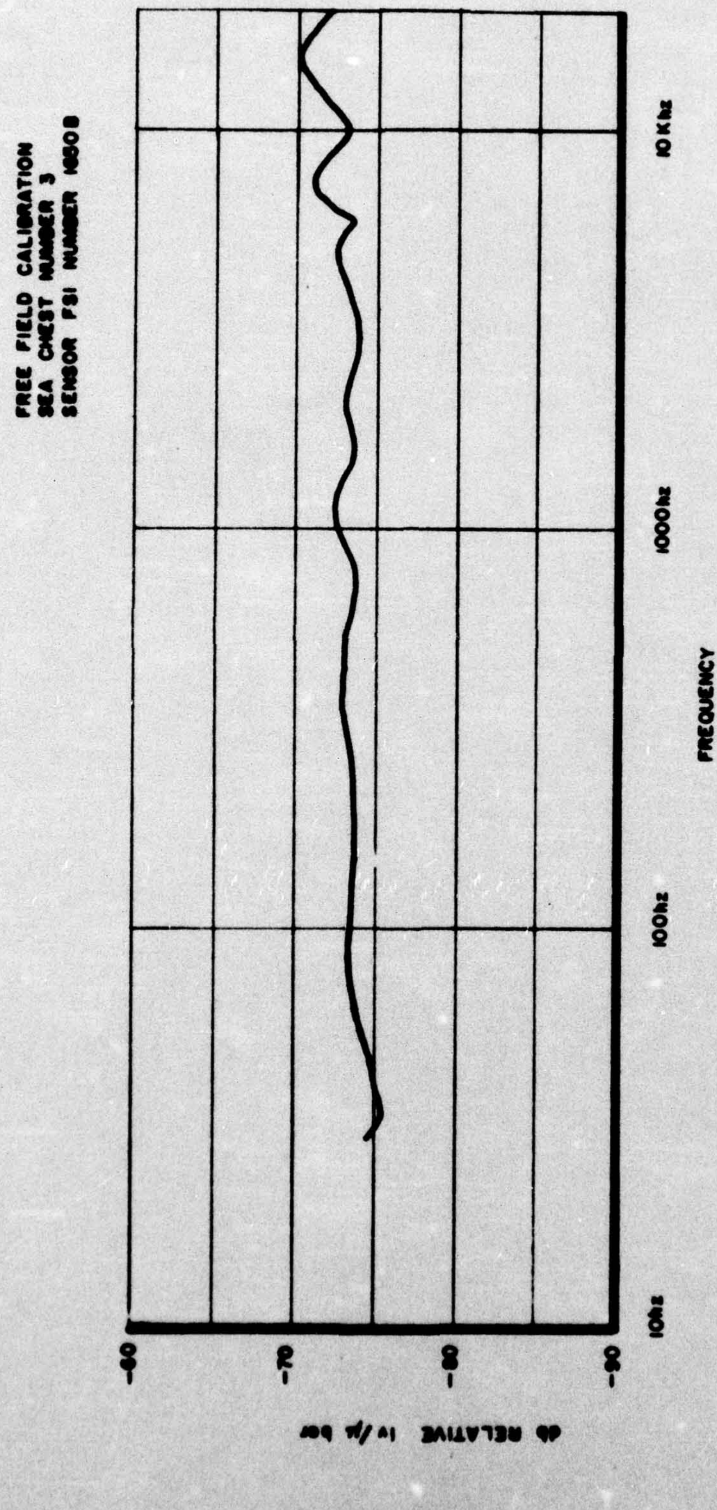
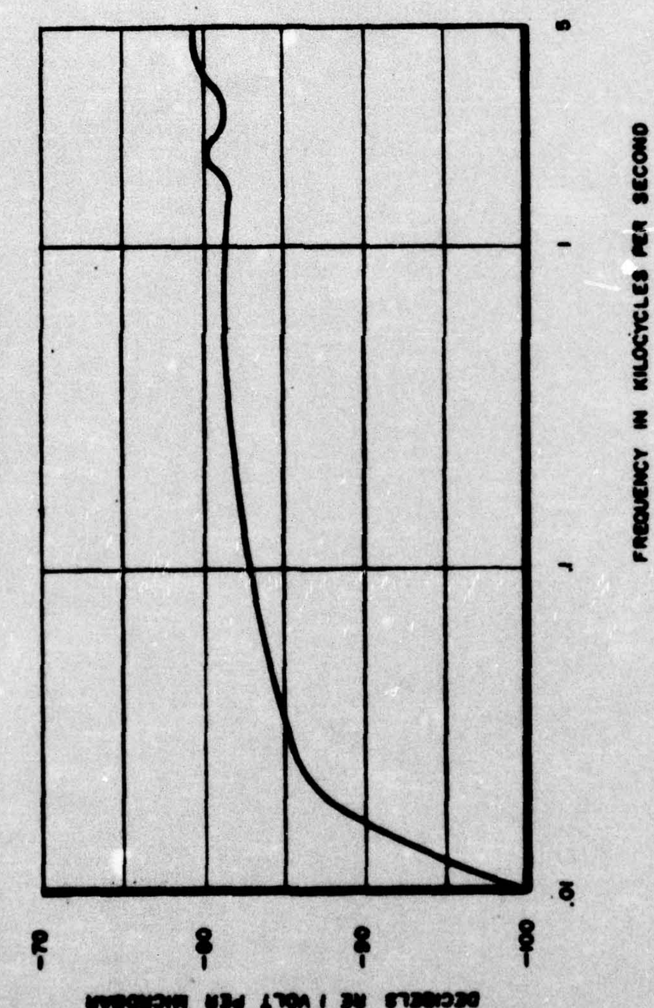

FREE FIELD CALIBRATION
SEA CHEST NUMBER 3
SENSOR FSI NUMBER
10Khz
1000hz
100hz
10hz
FREQUENCY
-60
-70
-80
-90
dB RELATIVE 1v/µ bar

FIGURE 2-4

HYDROPHONE VOLTAGE COUPLING (RATIO IN DECIBELS OF VOLTAGE AT PRE-AMPLIFIER OUTPUT TO OPEN-CIRCUIT CRYSTAL VOLTAGE):

10 Hz : -10.1 dB
20 Hz : -1.9 dB
49 Hz : -4.7 dB

100 Hz TO 20KHz : 0.0 dB



FREE-FIELD VOLTAGE SENSITIVITY

5E HYDROPHONE SERIAL 103

VOLTAGE ACROSS 150-OHM RESISTOR AT END OF 100-FT CABLE

FIGURE 2-5

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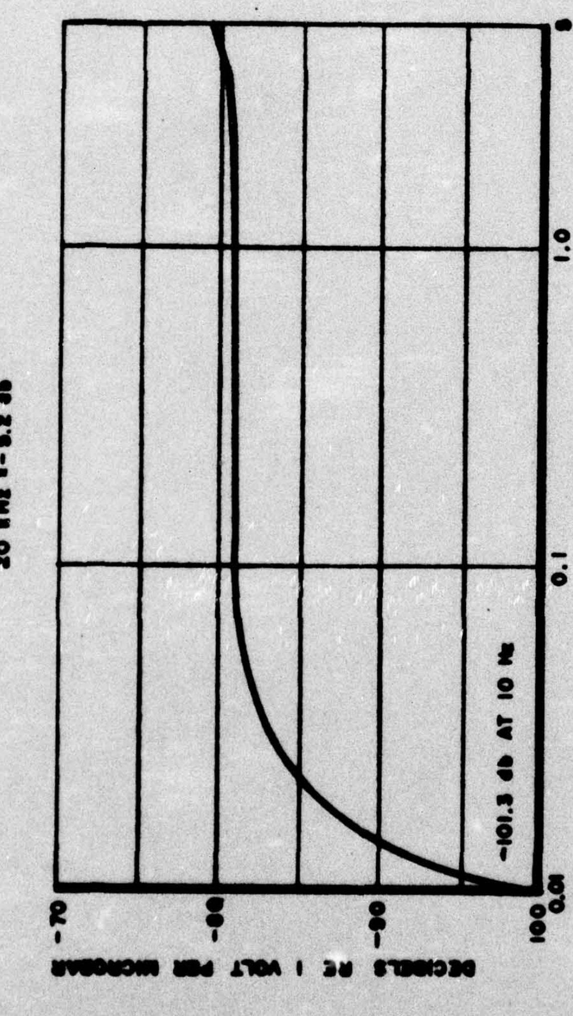
HYDROPHONE VOLTAGE COUPLING (RATIO IN DECIBELS OF VOLTAGE AT PREAMPLIFIER OUTPUT TO OPEN - CIRCUIT CRYSTAL VOLTAGE):
10 Hz = -10.2 db
20 Hz = -6.7 db
1 TO 10 kHz = -4.4 db
20 kHz = -5.2 db



FREQUENCY IN KILOCYCLES PER SECOND (kHz)

FREE - FIELD VOLTAGE SENSITIVITY
SE HYDROPHONE SERIAL 61
VOLTAGE ACROSS 135-OHM RESISTOR AT END OF 50-FT CABLE

FIGURE 2-6

G.E. HYDROPHONE SENSITIVITY IN db REL 1v/μbar

SENSOR	FREQUENCY				
	1 KC	2 KC	3 KC	4 KC	5 KC
2L1	−55.0	−52.0	−49.6	−45.3	−42.3
2L2	−44.6	−40.6	−40.0	−36.5	−35.0
1L1	−57.3	−54.0	−50.6	−47.0	−43.7
1L2	−44.6	−40.4	−40.0	−36.5	−34.5
STAT	−55.7	−54.6	−55.2	−59.0	−53.7
MOVE 1	−55.8	−54.5	−55.2	−59.0	−53.8
MOVE 2	−54.6	−55.0	−57.5	−59.4	−57.0
MOVE 3	−55.5	−55.0	−54.0	−58.0	−56.8
MOVE 4	−54.8	−54.0	−56.6	−57.2	−56.0

FIGURE 2-7

PURVIS I AX-58 HYDROPHONE SENSITIVITY IN
db REL lv/μbar

FREQ hz	# 33	# 100	# 112	FREQ hz	# 33	# 100	# 112
20	-81	-81	-81	2.0K	-82	-83	-81
25	-81	-81	-81	2.5K	-82	-83	-81
32	-81	-81	-81	3.2K	-82	-84	-82
40	-81	-82	-81	4K	-82	-84	-83
50	-81	-82	-81	5K	-82	-84	-82
64	-81	-82	-81	6.4K	-80	-80	-81
80	-81	-82	-81	8K	-79	-78	-79
100	-81	-82	-81	10K	-77	-78	-78
125	-81	-82	-80				
160	-81	-83	-80				
200	-81	-83	-80				
250	-81	-83	-80				
320	-81	-83	-81				
400	-81	-83	-81				
500	-81	-83	-81				
640	-81	-83	-81				
800	-81	-83	-81				
1K	-82	-83	-81				
1.25K	-82	-83	-81				
1.6K	-82	-83	-82				

FIGURE 2-8

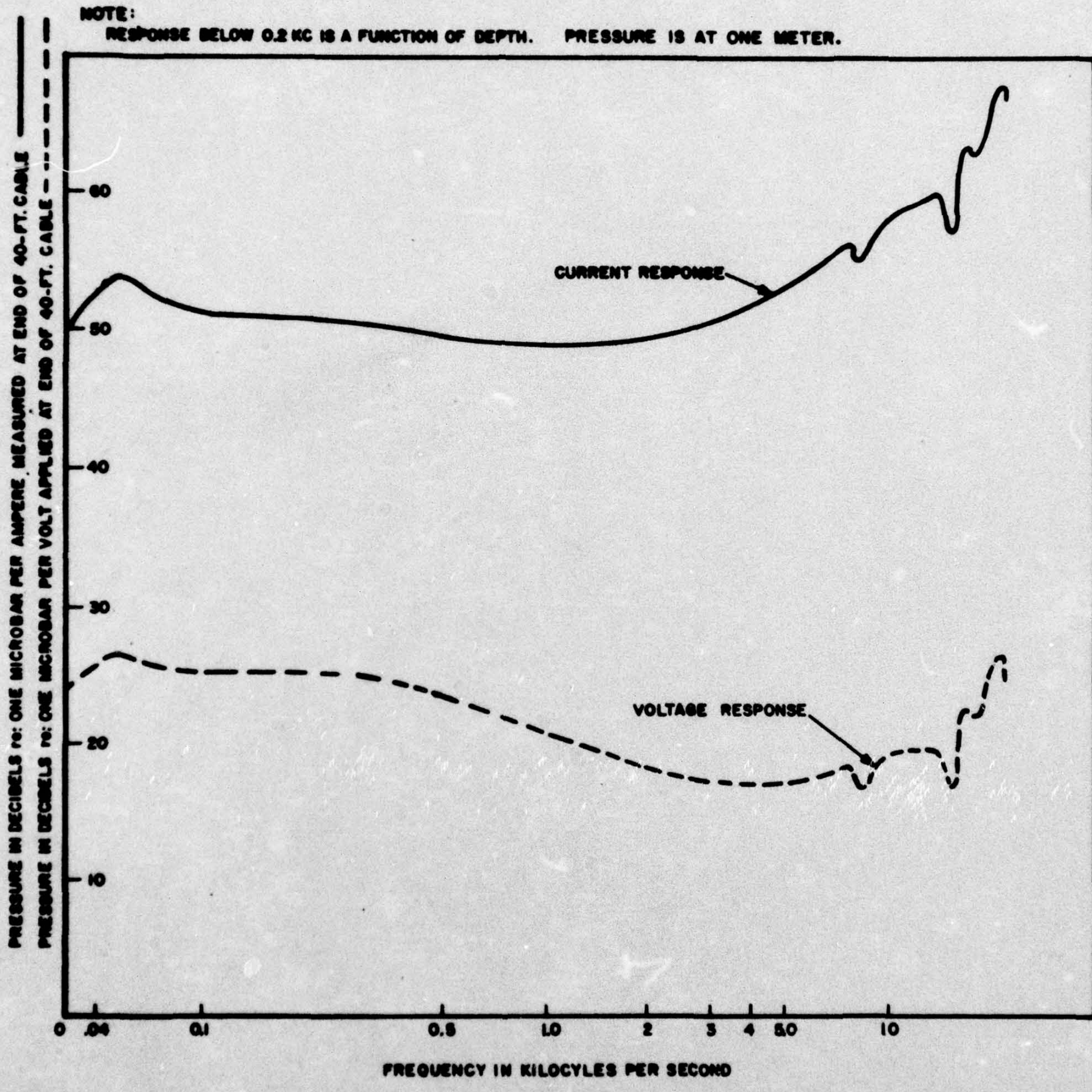


FIGURE 2-9. TRANSMITTING RESPONSE CURVES, J9 TRANSDUCER

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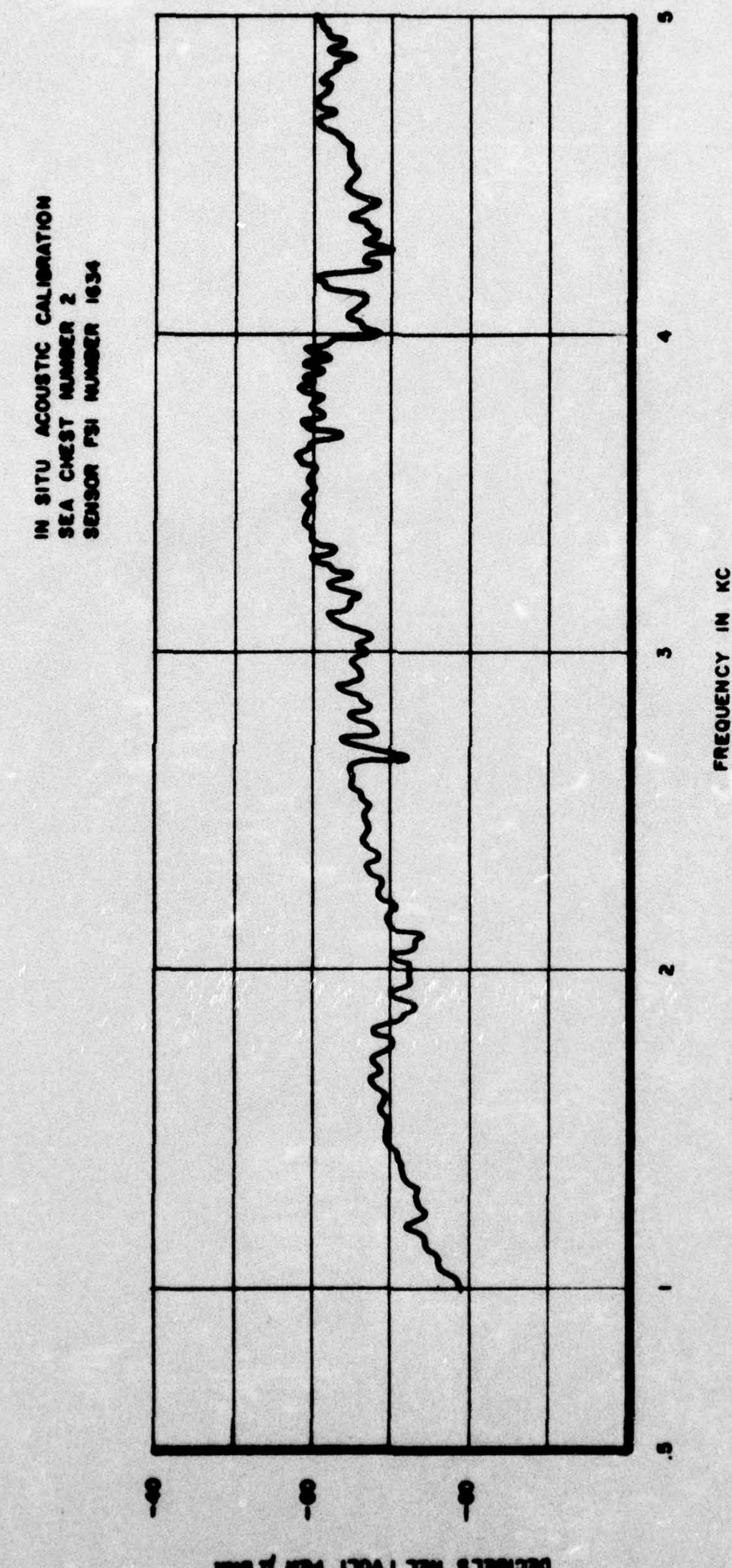

FIGURE 2-10

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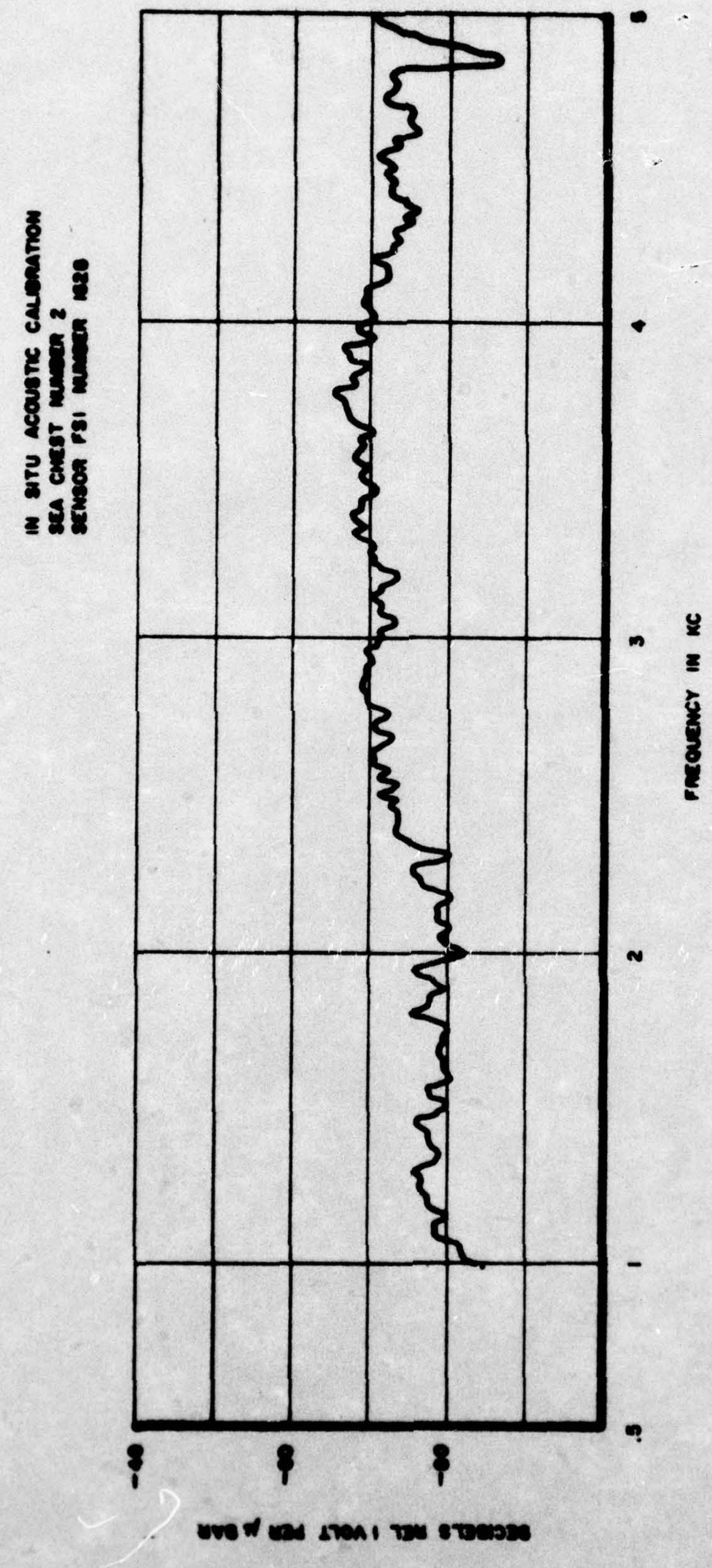

IN SITU ACOUSTIC CALIBRATION
SEA CHEST NUMBER 2
FREQUENCY IN KC
.5
1
2
3
4
8
DECIBELS REL 1 VOLT PER μ BAR

FIGURE 2-11

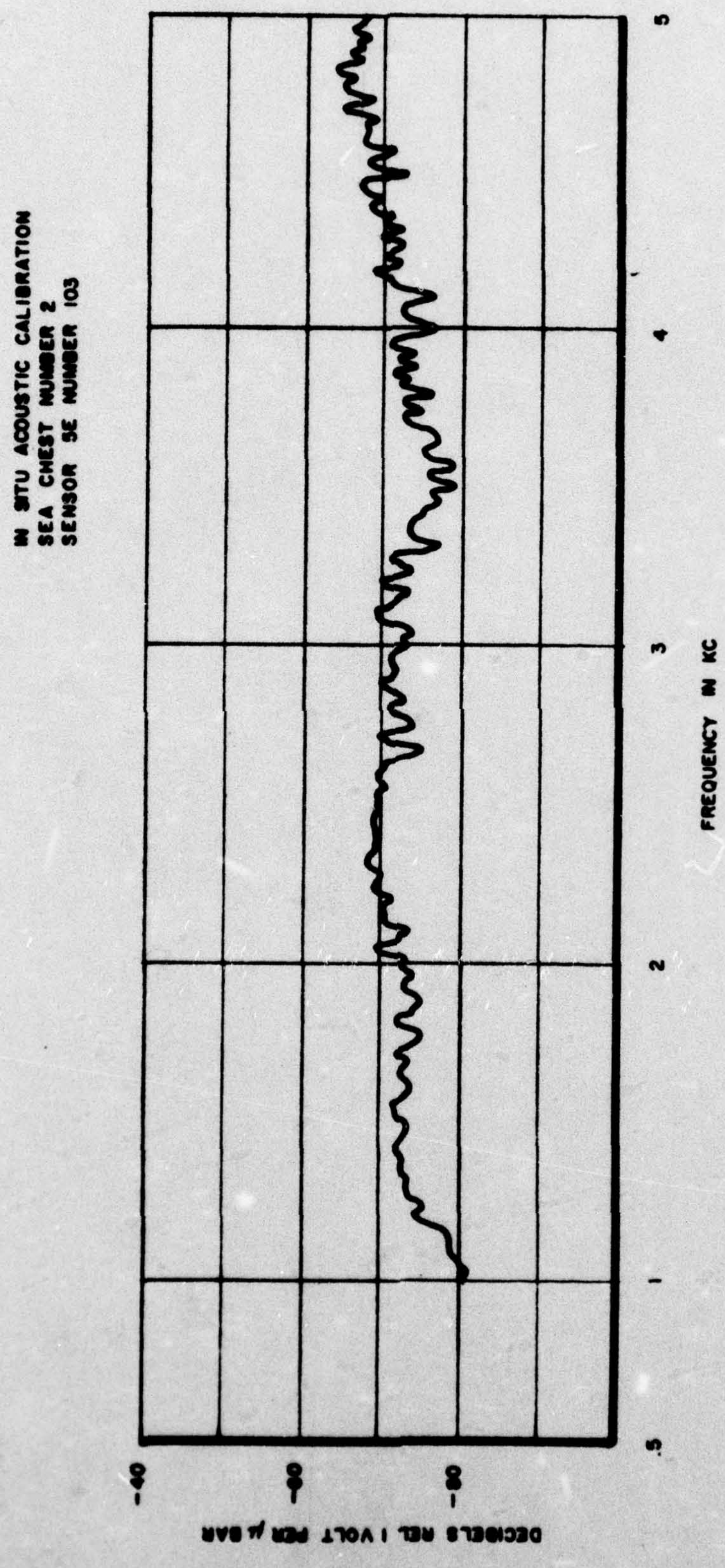

IN SITU ACOUSTIC CALIBRATION
SEA CHEST NUMBER 2
SENSOR 5E NUMBER 103
.5
1
2
3
4
5
FREQUENCY IN KC
-40
-60
-80
DECIBELS REL 1 VOLT PER μ BAR

FIGURE 2-12

B026-47007(A)

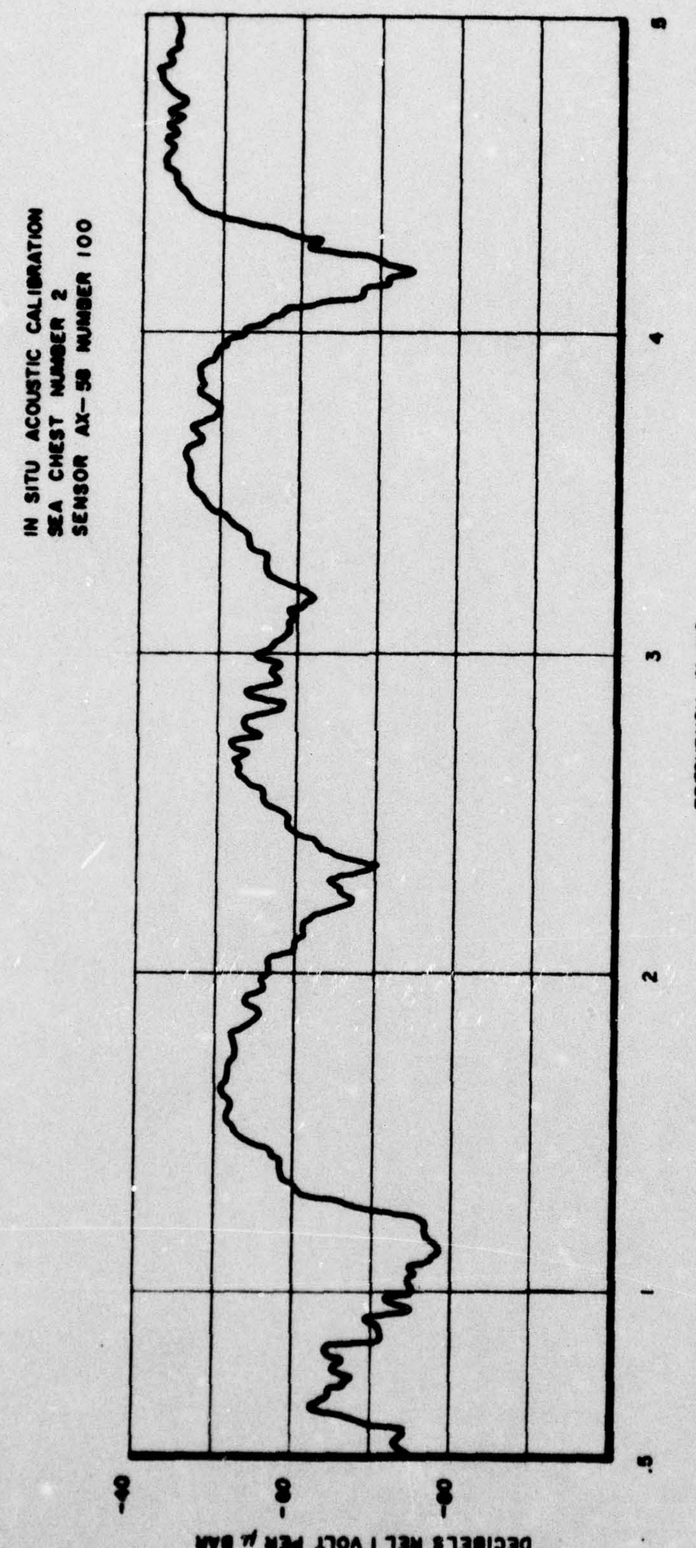


FIGURE 2-13

DECLASSIFIED ~~CONFIDENTIAL~~

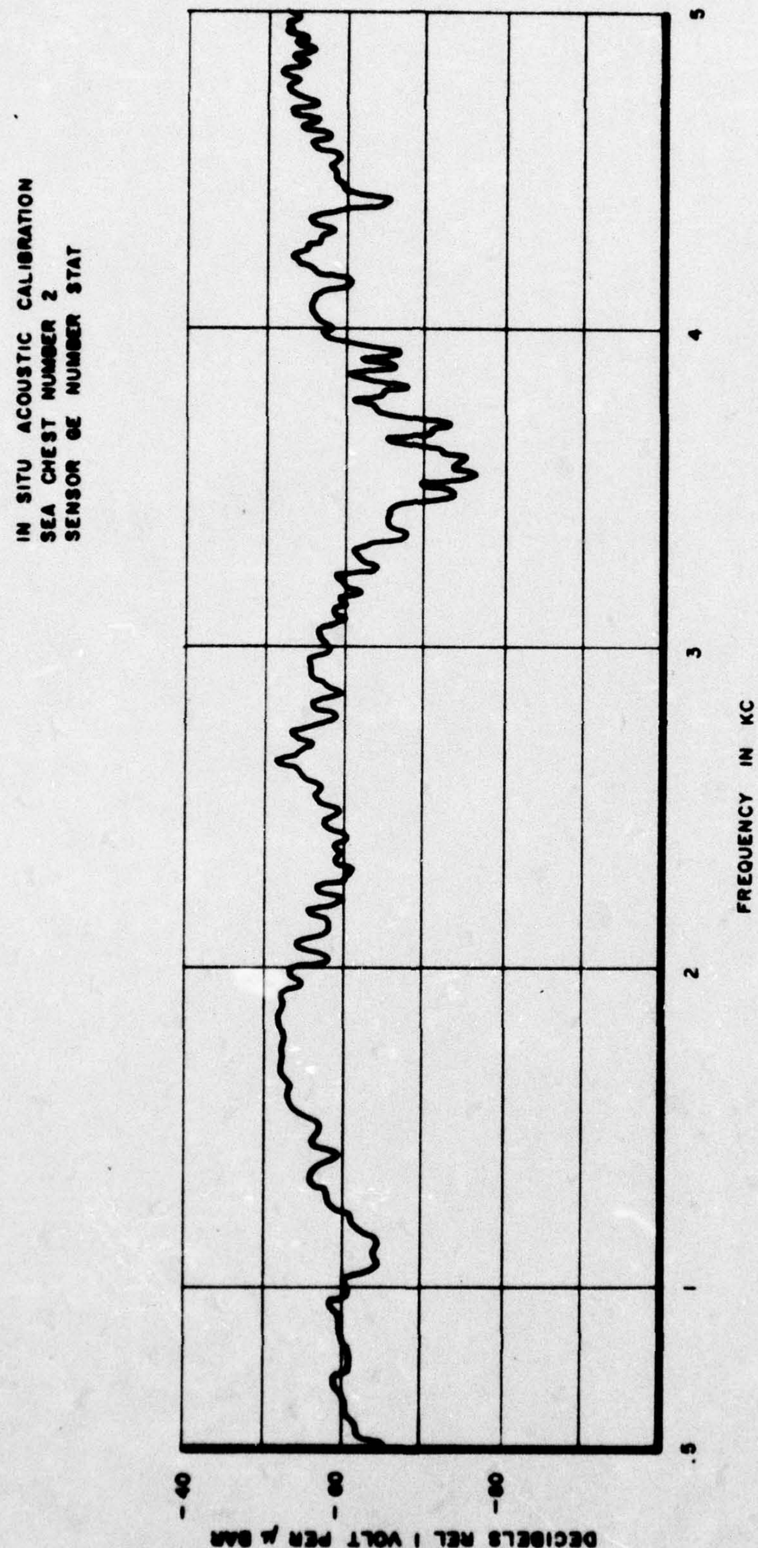


FIGURE 2-14

DECLASSIFIED ~~CONFIDENTIAL~~

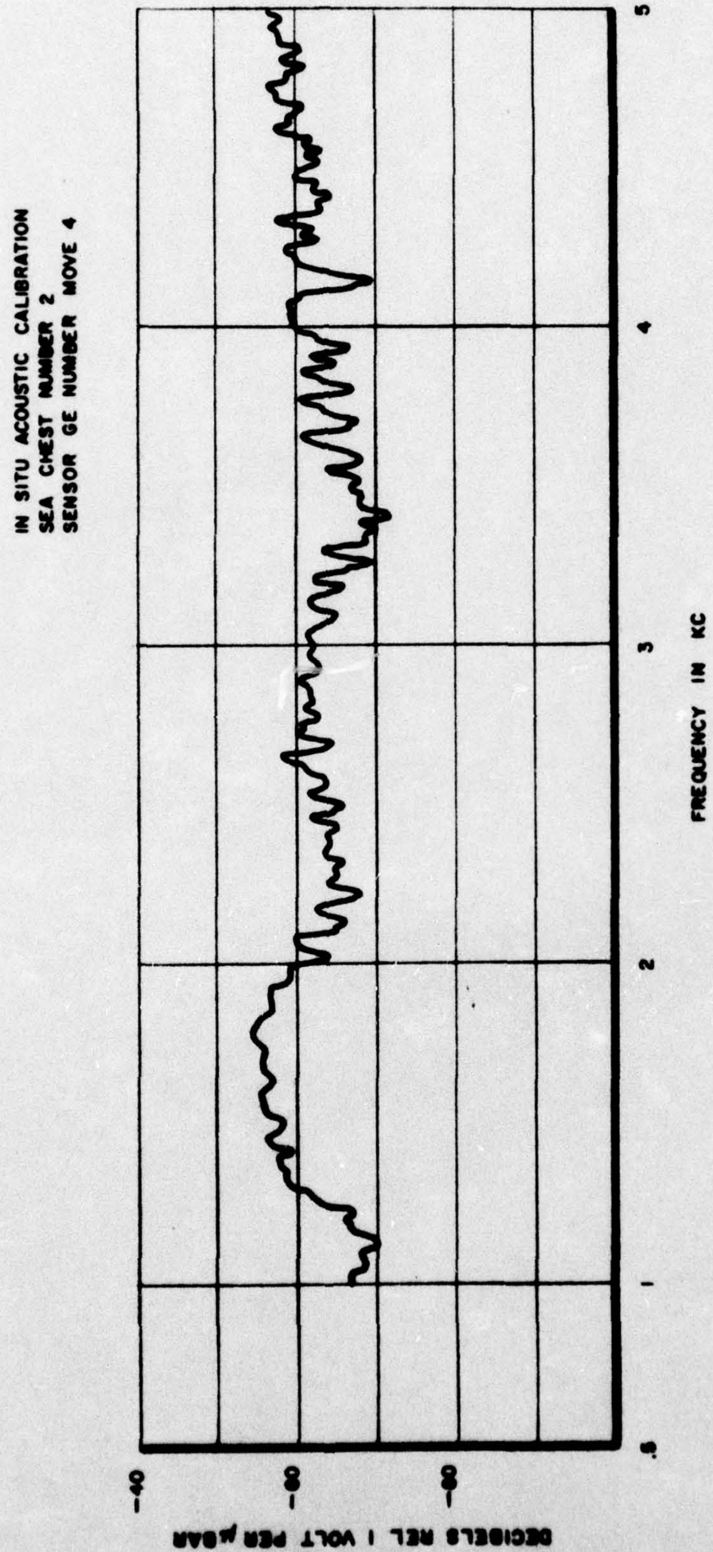

IN SITU ACOUSTIC CALIBRATION
SEA CHEST NUMBER 2
SENSOR GE NUMBER MOVE 4
-40
-60
-80
DECIBELS REL 1 VOLT PER μBAR
.5
1
2
3
4
5
FREQUENCY IN KC

FIGURE 2-15

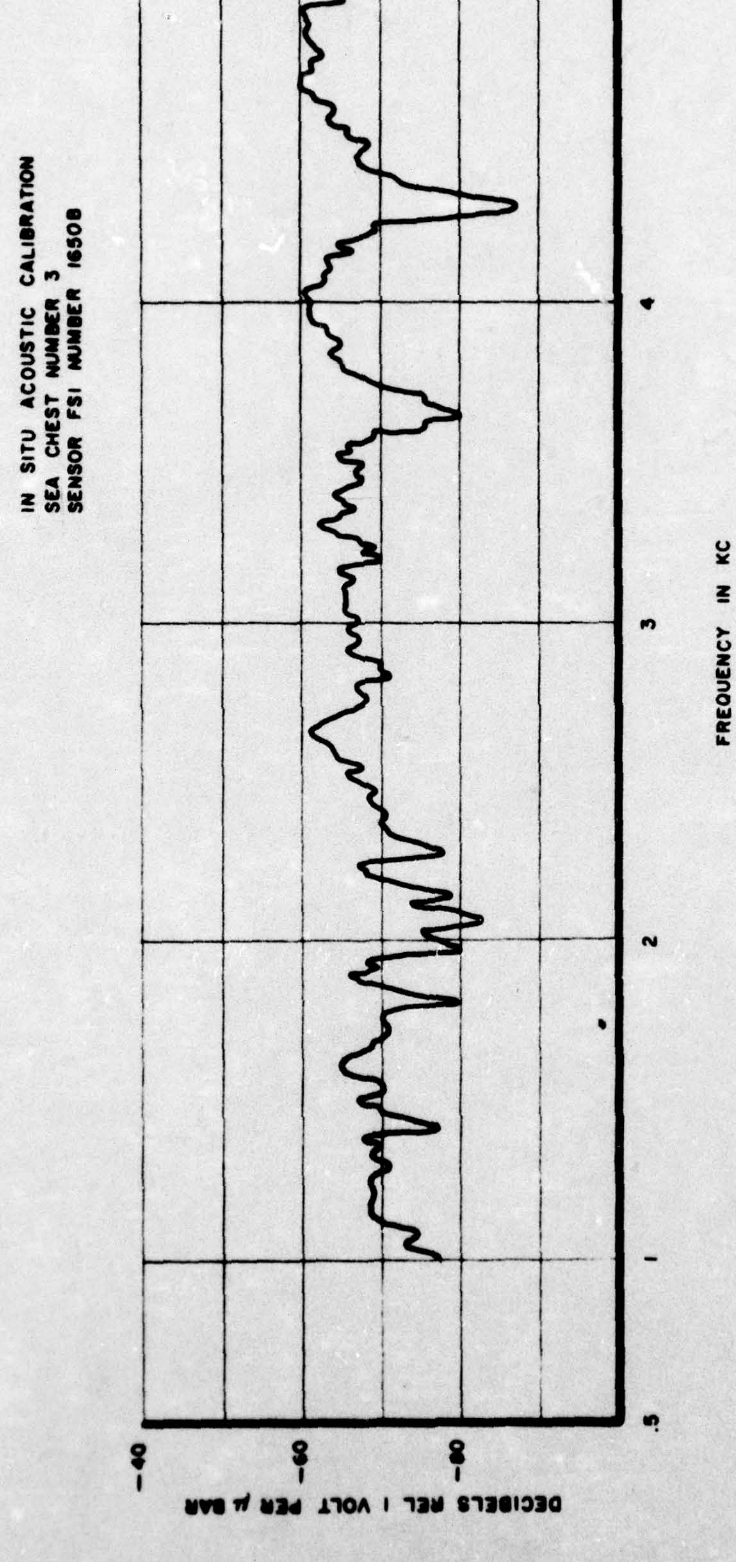

IN SITU ACOUSTIC CALIBRATION
SEA CHEST NUMBER 3
SENSOR FSI NUMBER 1650B
-40
-60
-80
DECIBELS REL 1 VOLT PER μ BAR
.5
1
2
3
4
5
FREQUENCY IN KC

FIGURE 2-16

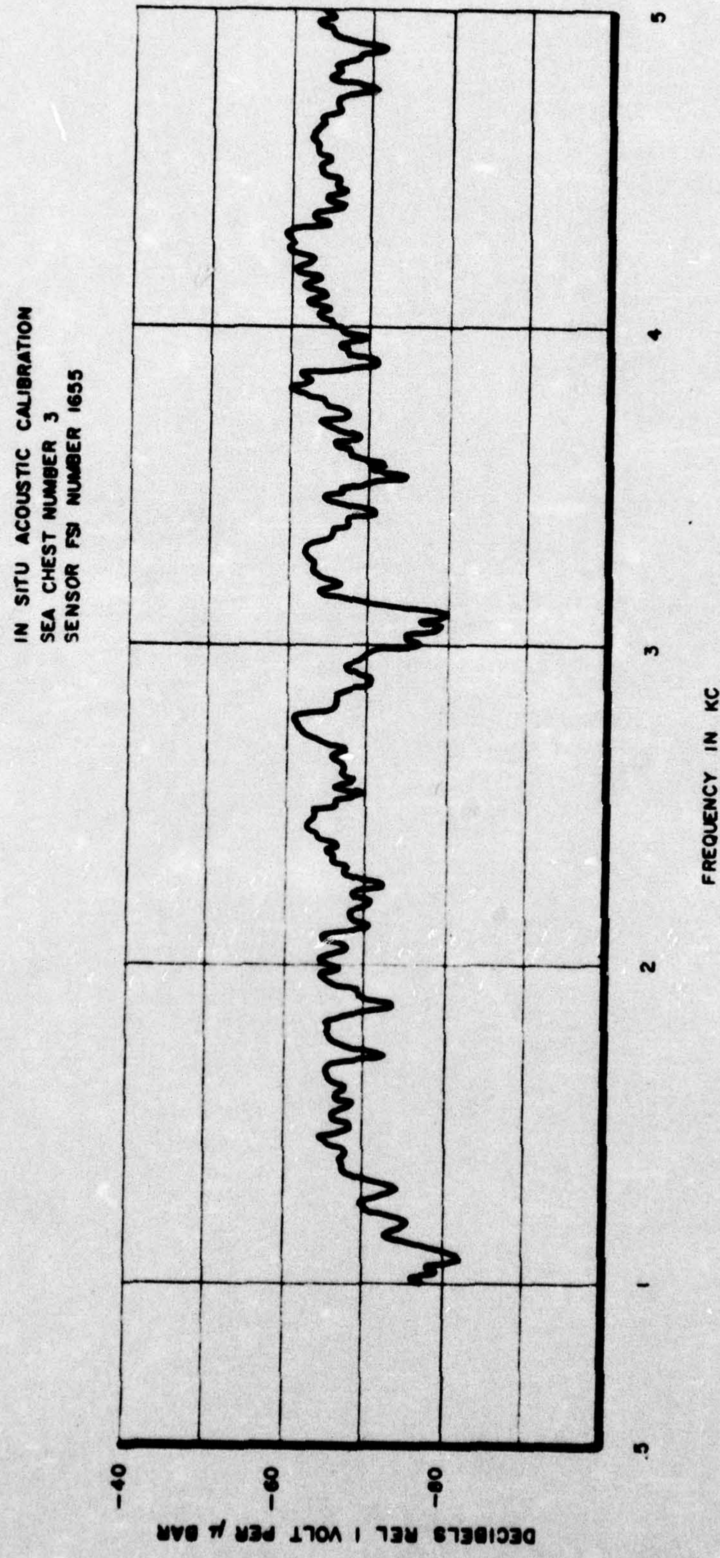

IN SITU ACOUSTIC CALIBRATION
SEA CHEST NUMBER 3
SENSOR FSI NUMBER 1655
FREQUENCY IN KC
DECIBELS REL 1 VOLT PER μ BAR
-40
-60
-80
.5
1
2
3
4
5

FIGURE 2-17

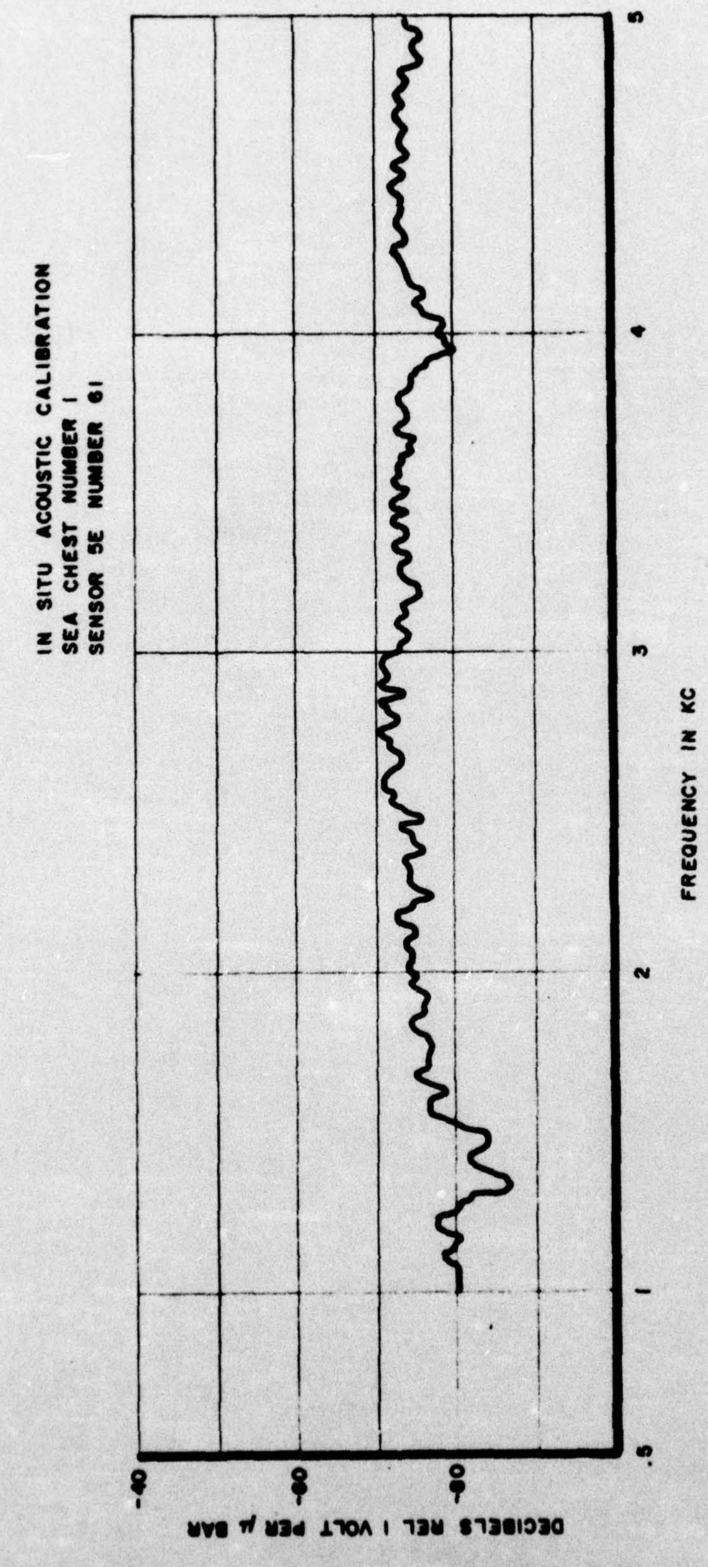

IN SITU ACOUSTIC CALIBRATION
SEA CHEST NUMBER 1
SENSOR 5E NUMBER 61
-40
-60
-80
DECIBELS REL 1 VOLT PER μ BAR
.5
1
2
3
4
5
FREQUENCY IN KC

FIGURE 2-18

B026-47007 (A)

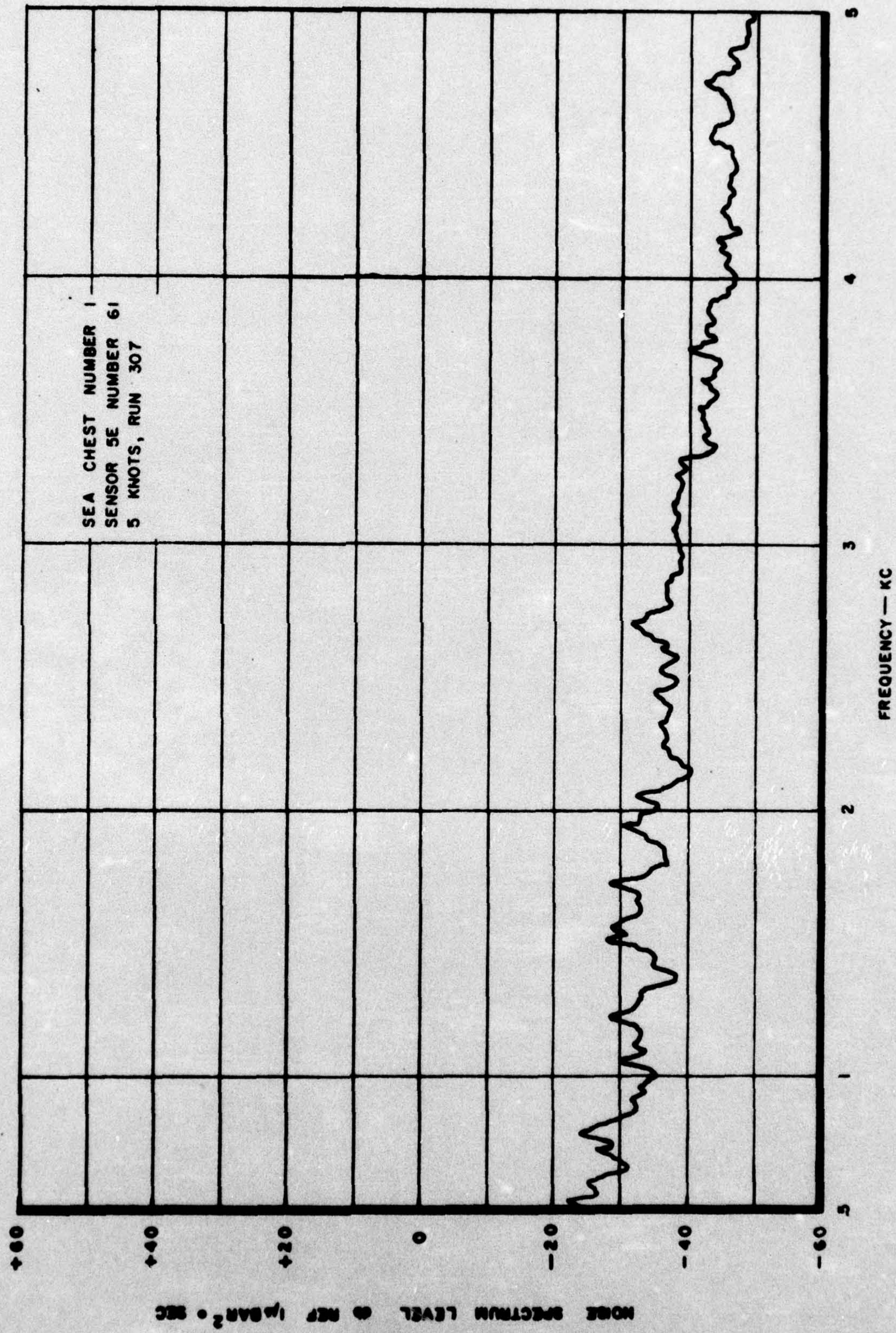


FIGURE 2-19

B026-47007(A)

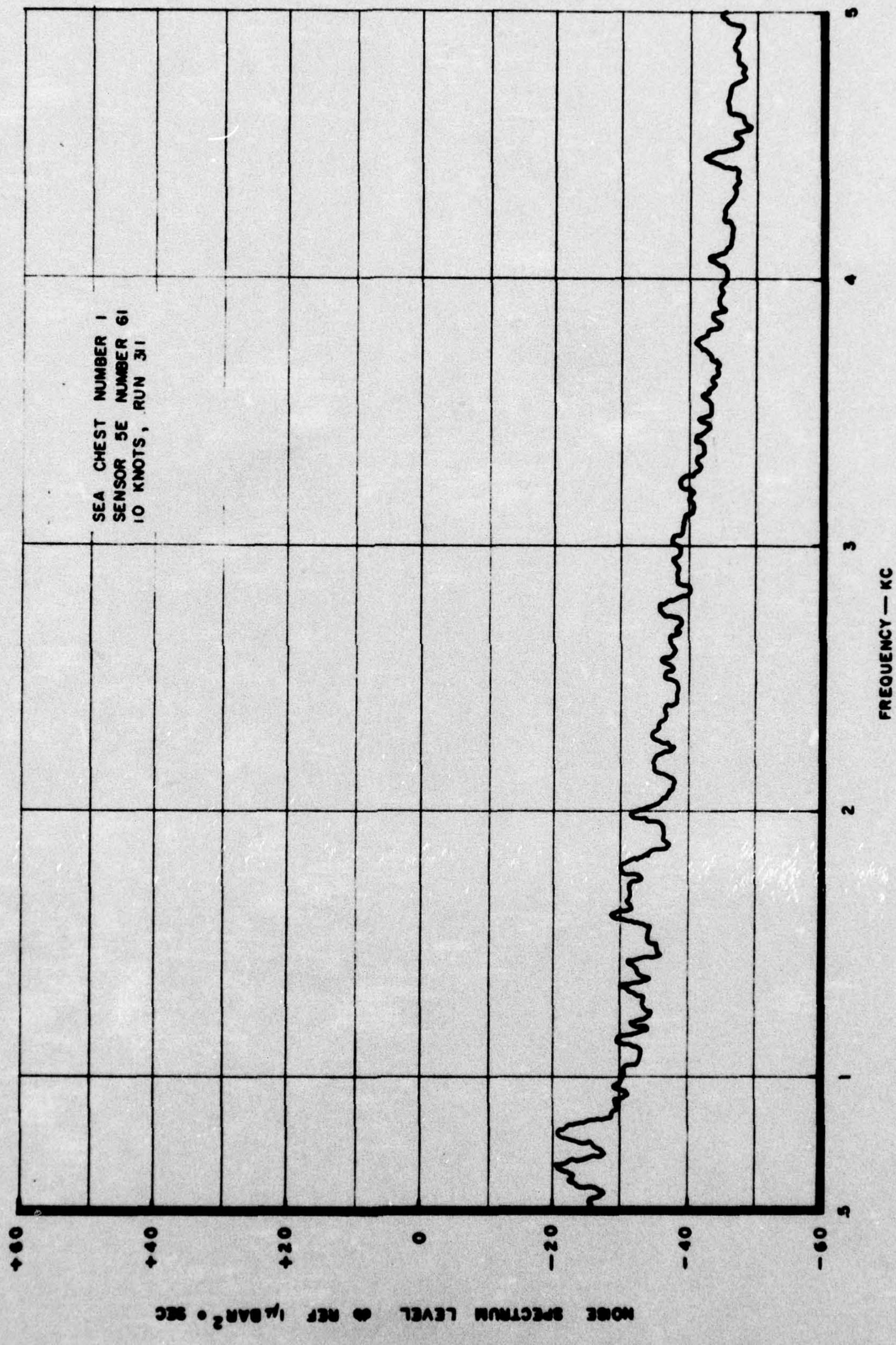


FIGURE 2-20

B026-47007(A)

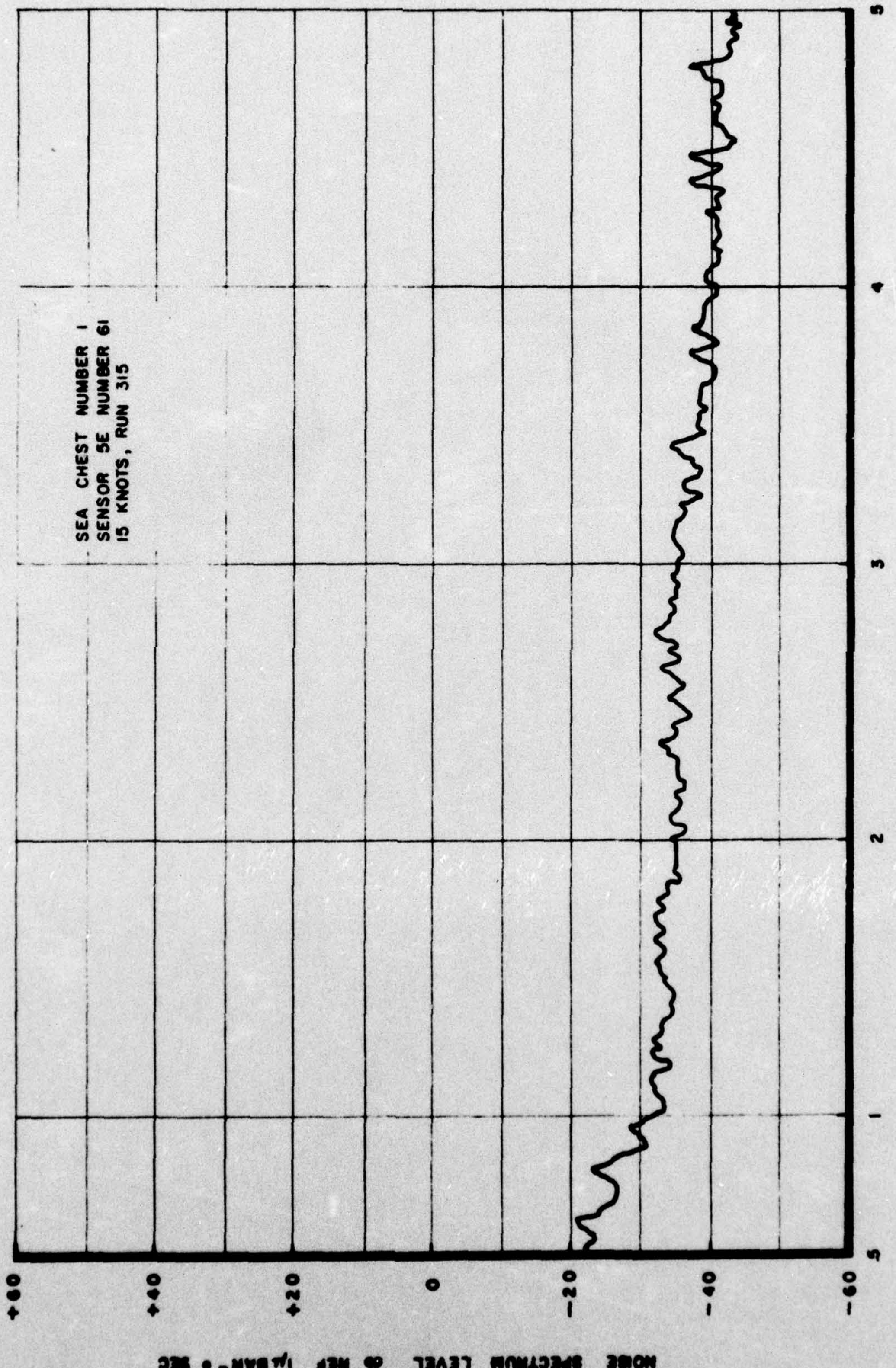


FIGURE 2-21

B026-47007 (A)

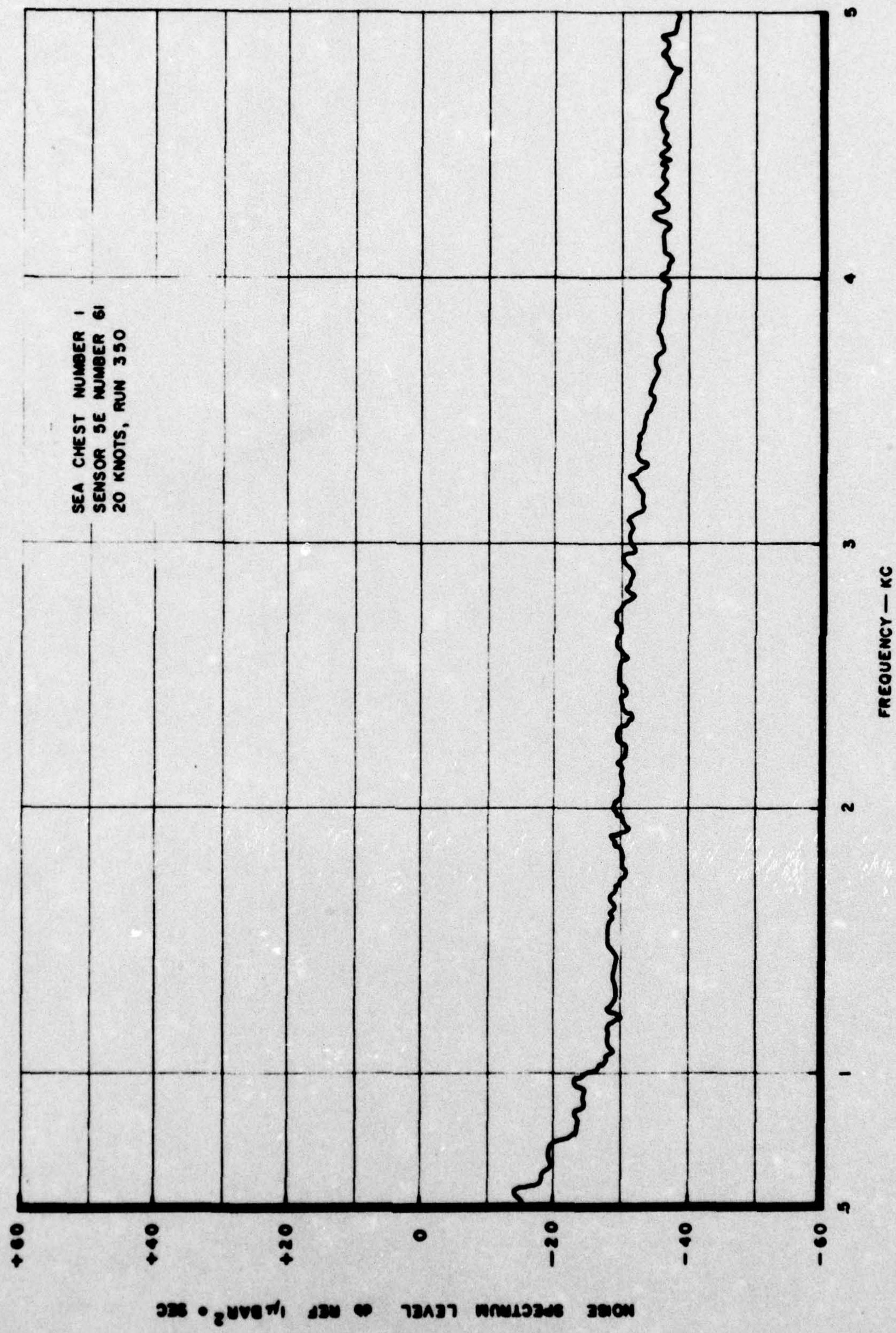


FIGURE 2-22

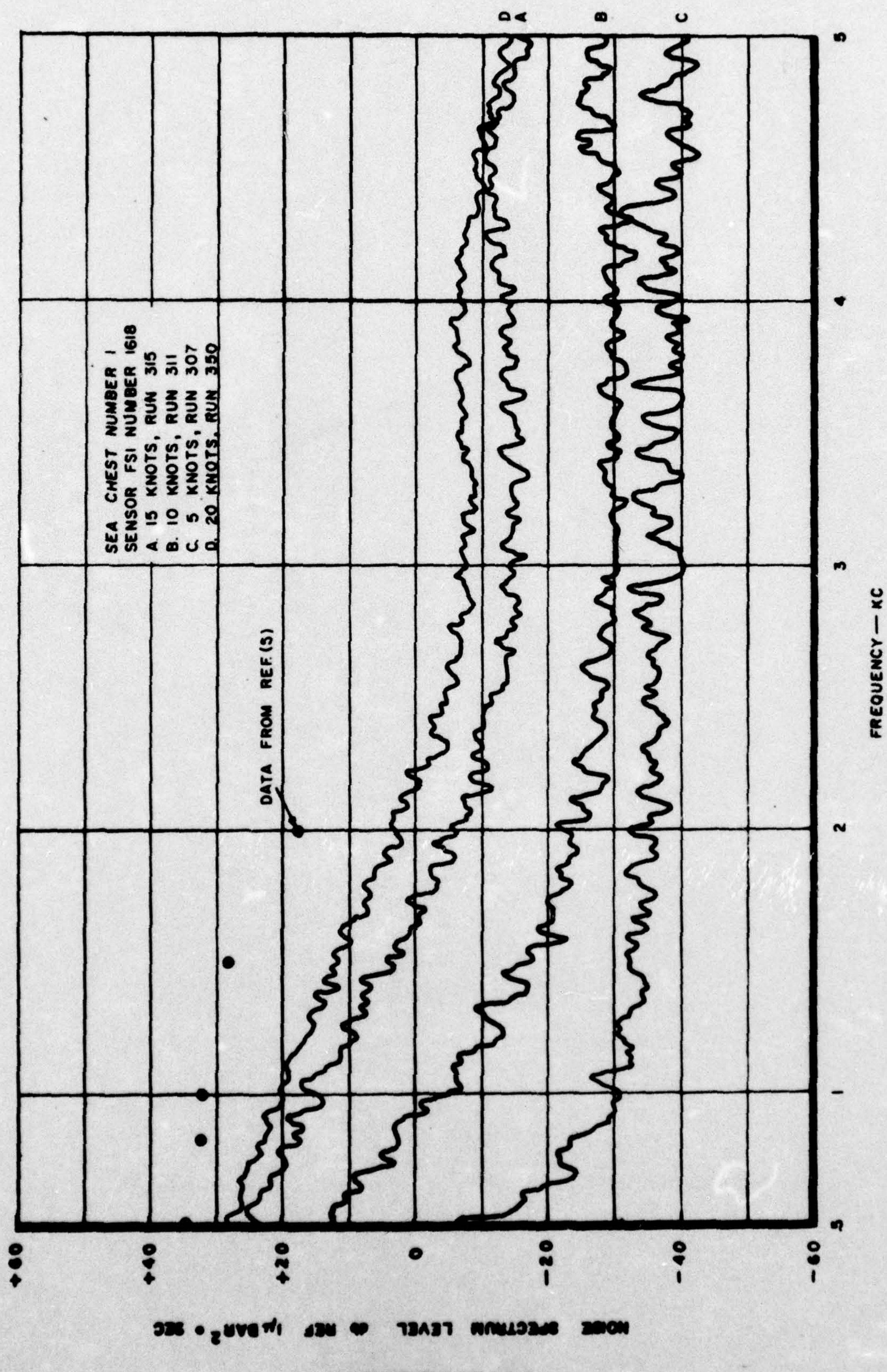

SEA CHEST NUMBER 1
SENSOR FSI NUMBER 1618
A 15 KNOTS, RUN 315
B. 10 KNOTS, RUN 311
C. 5 KNOTS, RUN 307
D. 20 KNOTS, RUN 350
DATA FROM REF.(5)
D
A
B
C
+60
+40
+20
0
-20
-40
-60
.5
1
2
3
4
5
FREQUENCY — KC
NOISE SPECTRUM LEVEL db REF 1 μBAR² • SEC

FIGURE 2-23

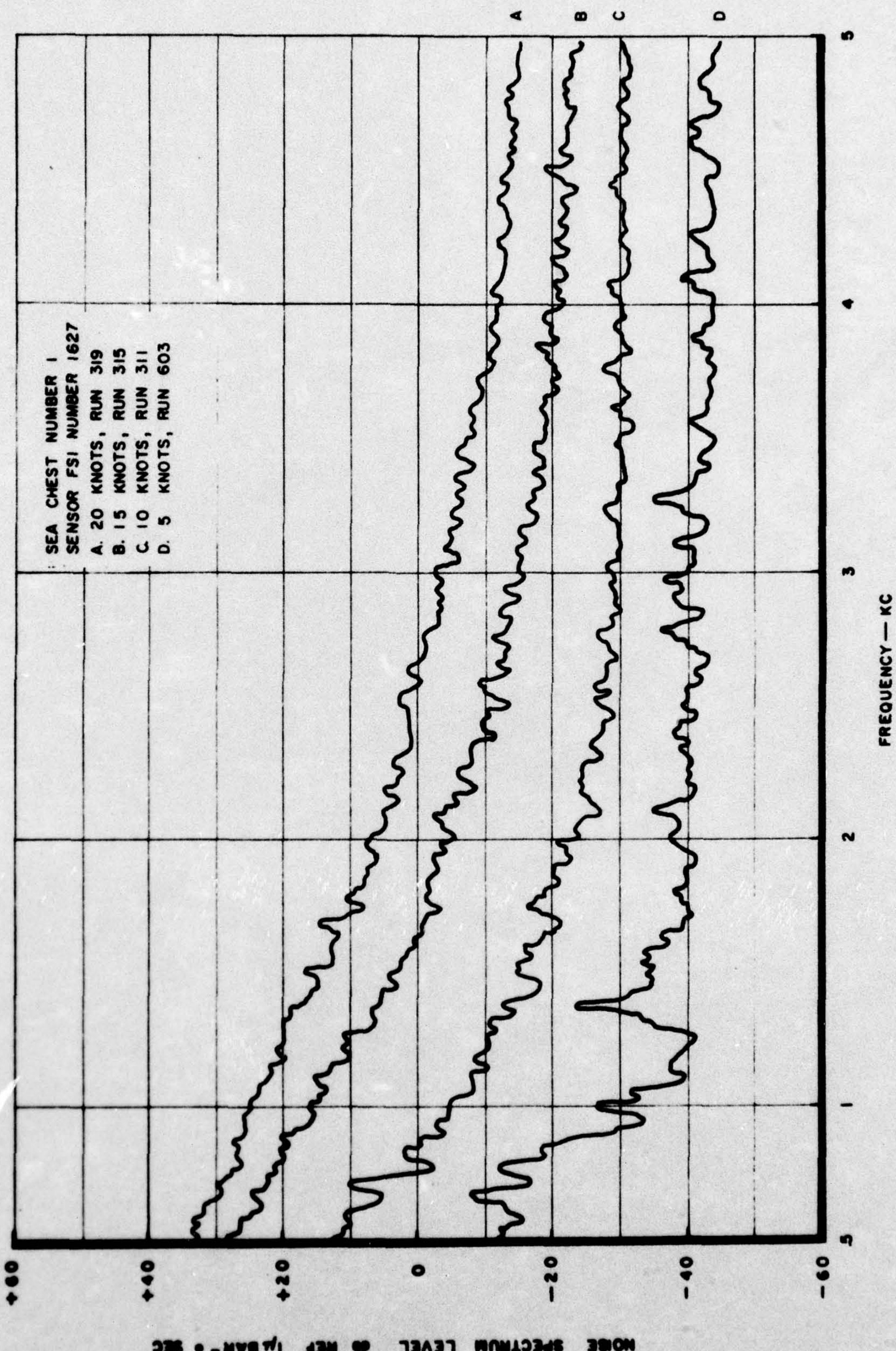

SEA CHEST NUMBER 1
SENSOR FSI NUMBER 1627
A. 20 KNOTS, RUN 319
B. 15 KNOTS, RUN 315
C. 10 KNOTS, RUN 311
D. 5 KNOTS, RUN 603
A
B
C
D
+60
+40
+20
0
-20
-40
-60
.5
1
2
3
4
5
FREQUENCY — KC
NOISE SPECTRUM LEVEL db REF 1 μBAR² • SEC

FIGURE 2-24

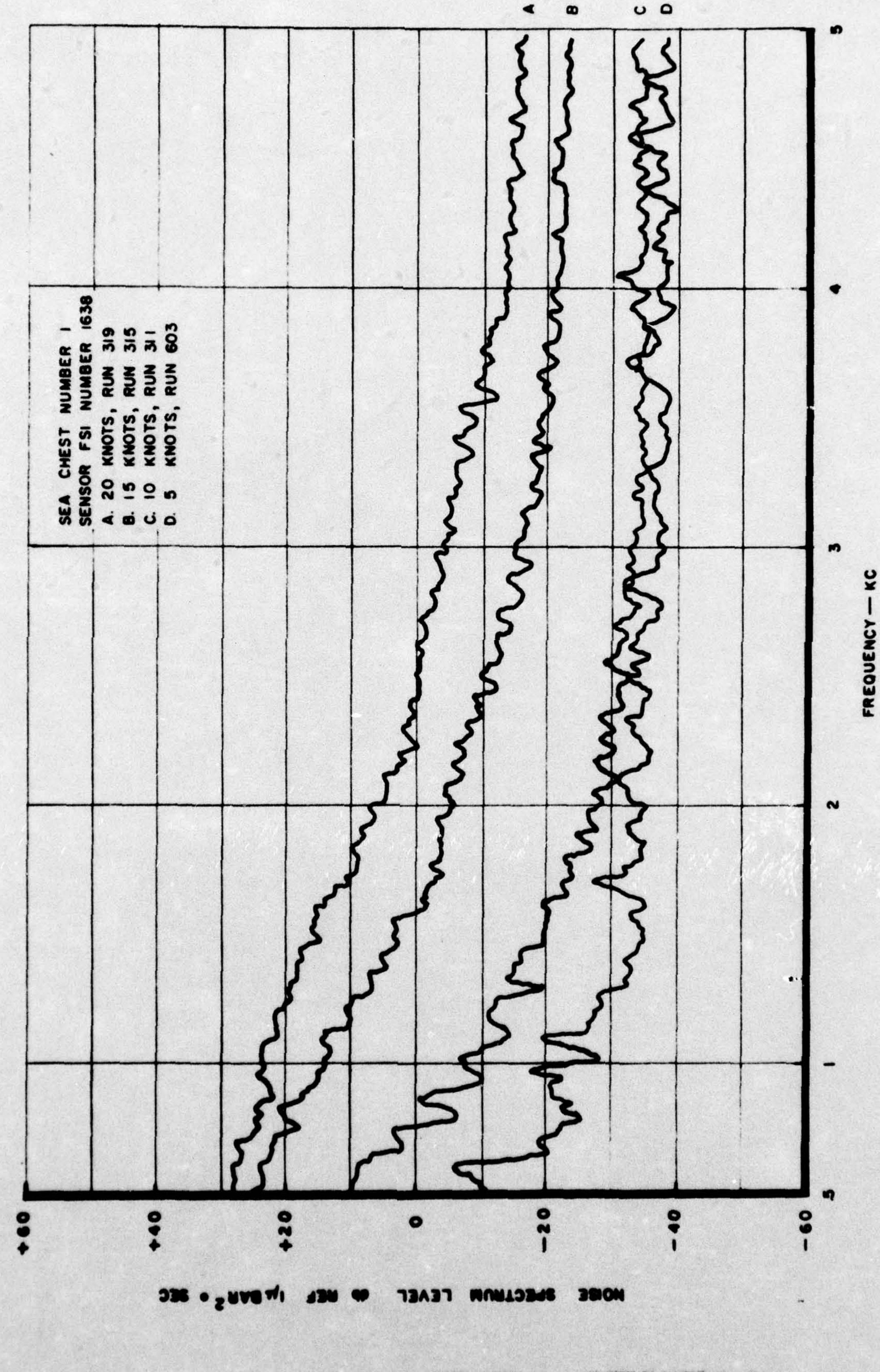

SEA CHEST NUMBER 1
SENSOR FSI NUMBER 1638
A. 20 KNOTS, RUN 319
B. 15 KNOTS, RUN 315
C. 10 KNOTS, RUN 311
D. 5 KNOTS, RUN 603
A
B
C
D
+60
+40
+20
0
-20
-40
-60
1
2
3
4
5
FREQUENCY — KC
NOISE SPECTRUM LEVEL db REF 1 μBAR² • SEC

FIGURE 2-25

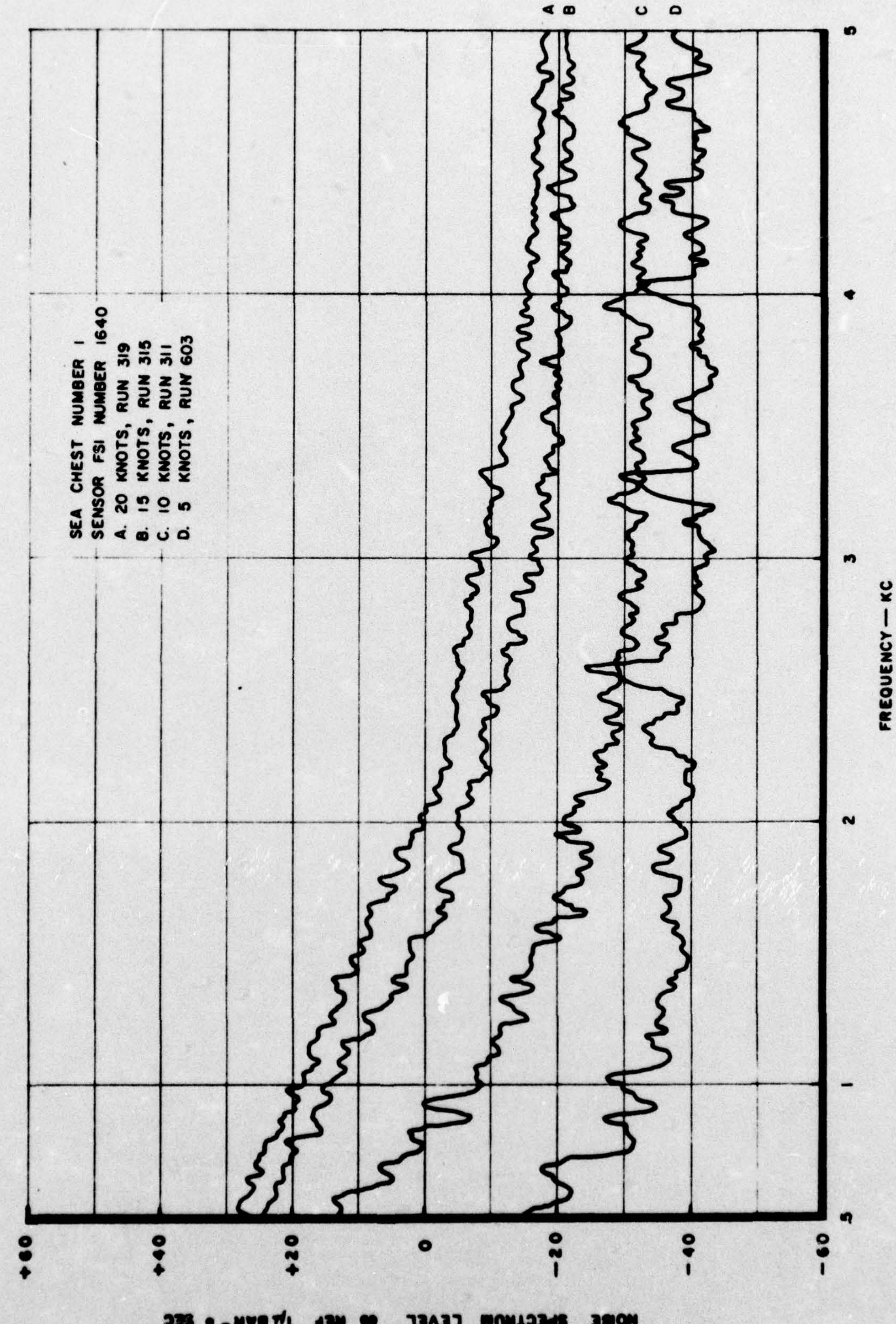

SEA CHEST NUMBER 1
SENSOR FSI NUMBER 1640
A. 20 KNOTS, RUN 319
B. 15 KNOTS, RUN 315
C. 10 KNOTS, RUN 311
D. 5 KNOTS, RUN 603
A
B
C
D
+60
+40
+20
0
-20
-40
-60
.5
1
2
3
4
5
FREQUENCY — KC
NOISE SPECTRUM LEVEL db REF 1 μBAR² · SEC

FIGURE 2-26

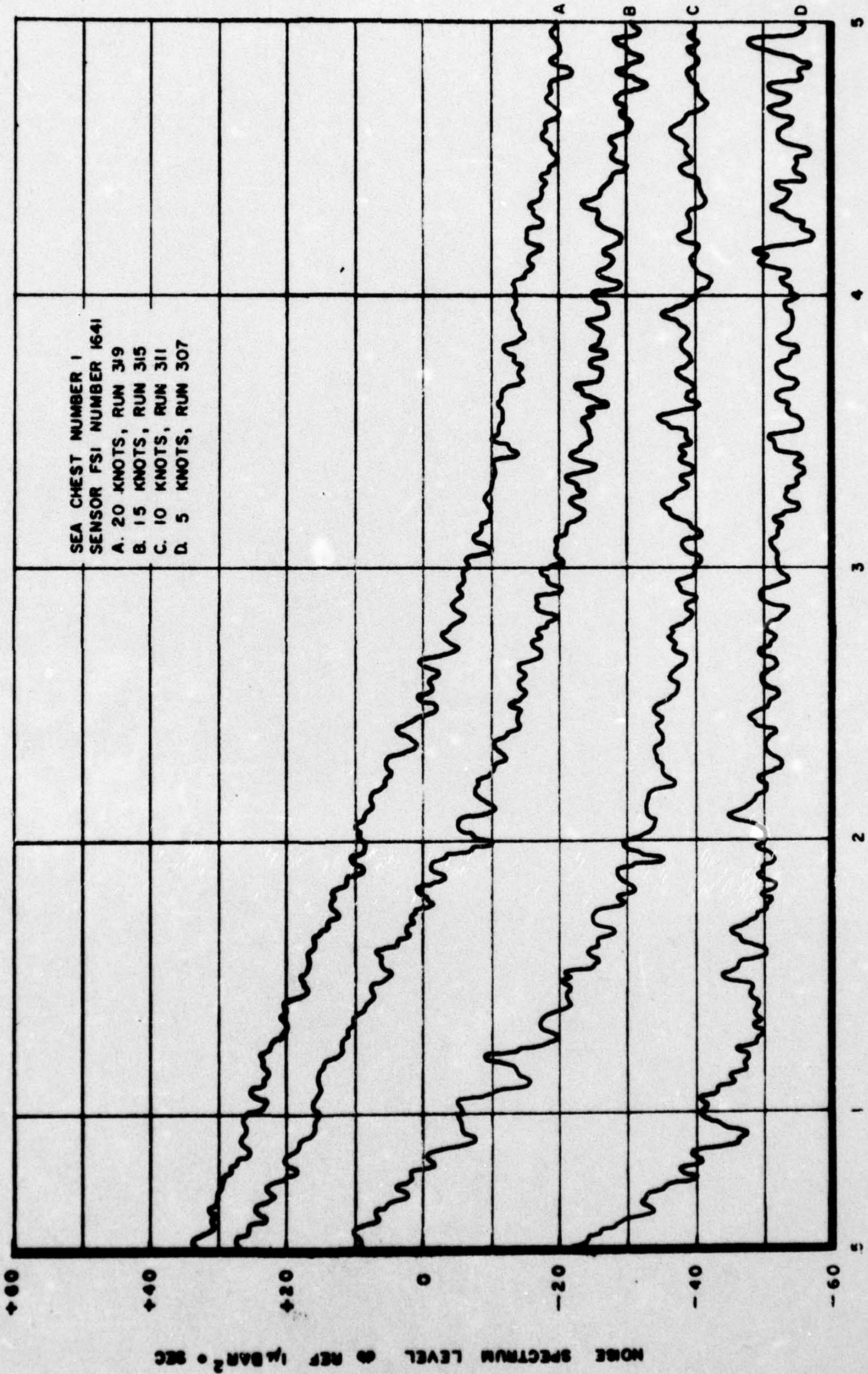

SEA CHEST NUMBER I
SENSOR FSI NUMBER 1641
A. 20 KNOTS, RUN 319
B. 15 KNOTS, RUN 315
C. 10 KNOTS, RUN 311
D. 5 KNOTS, RUN 307
A
B
C
D
+60
+40
+20
0
-20
-40
-60
1
2
3
4
5
FREQUENCY — KC
NOISE SPECTRUM LEVEL db REF 1μBAR²· SEC

FIGURE 2-27

B026-47007 (A)

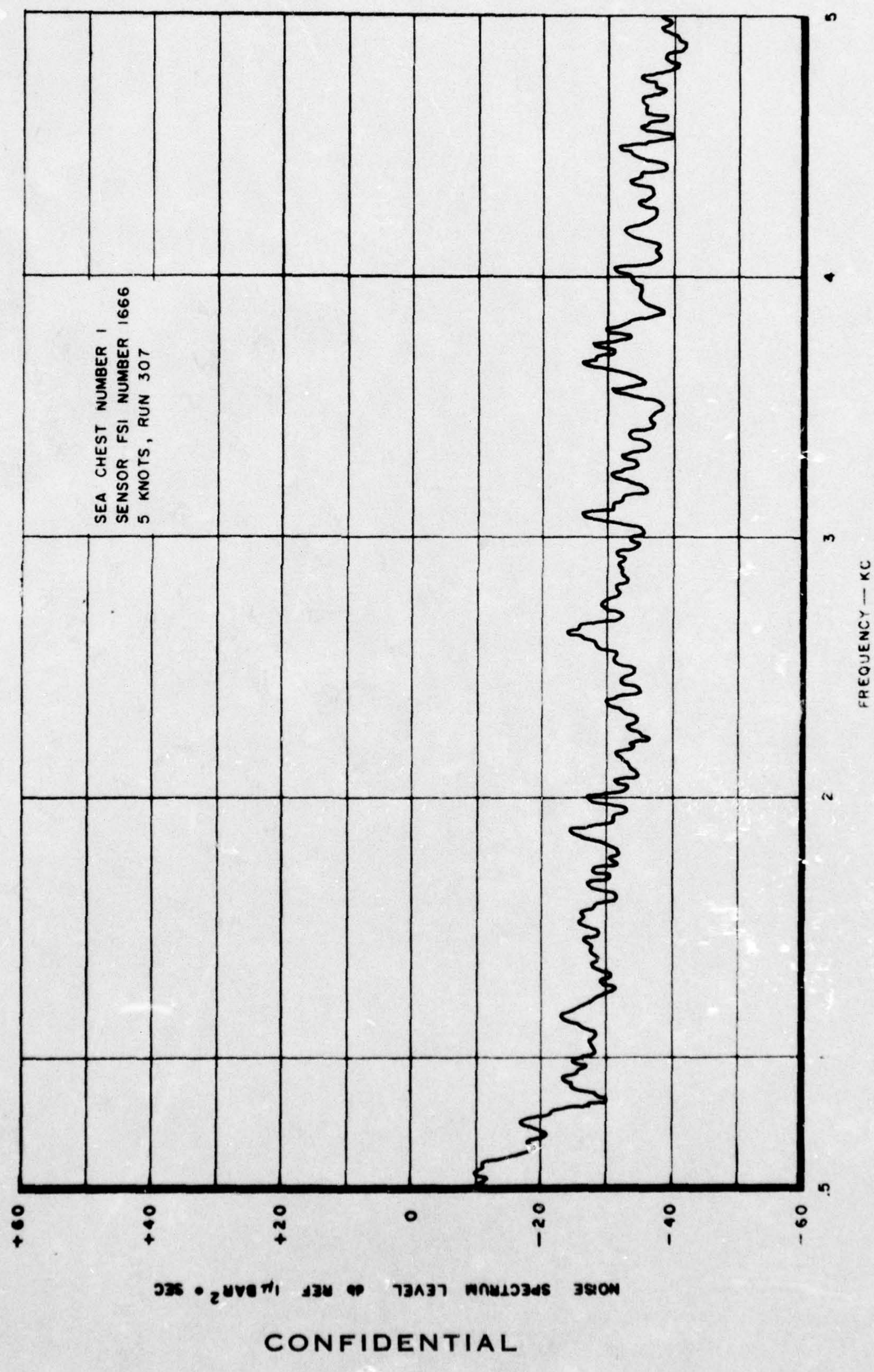


FIGURE 2-28

B026-47007(A)

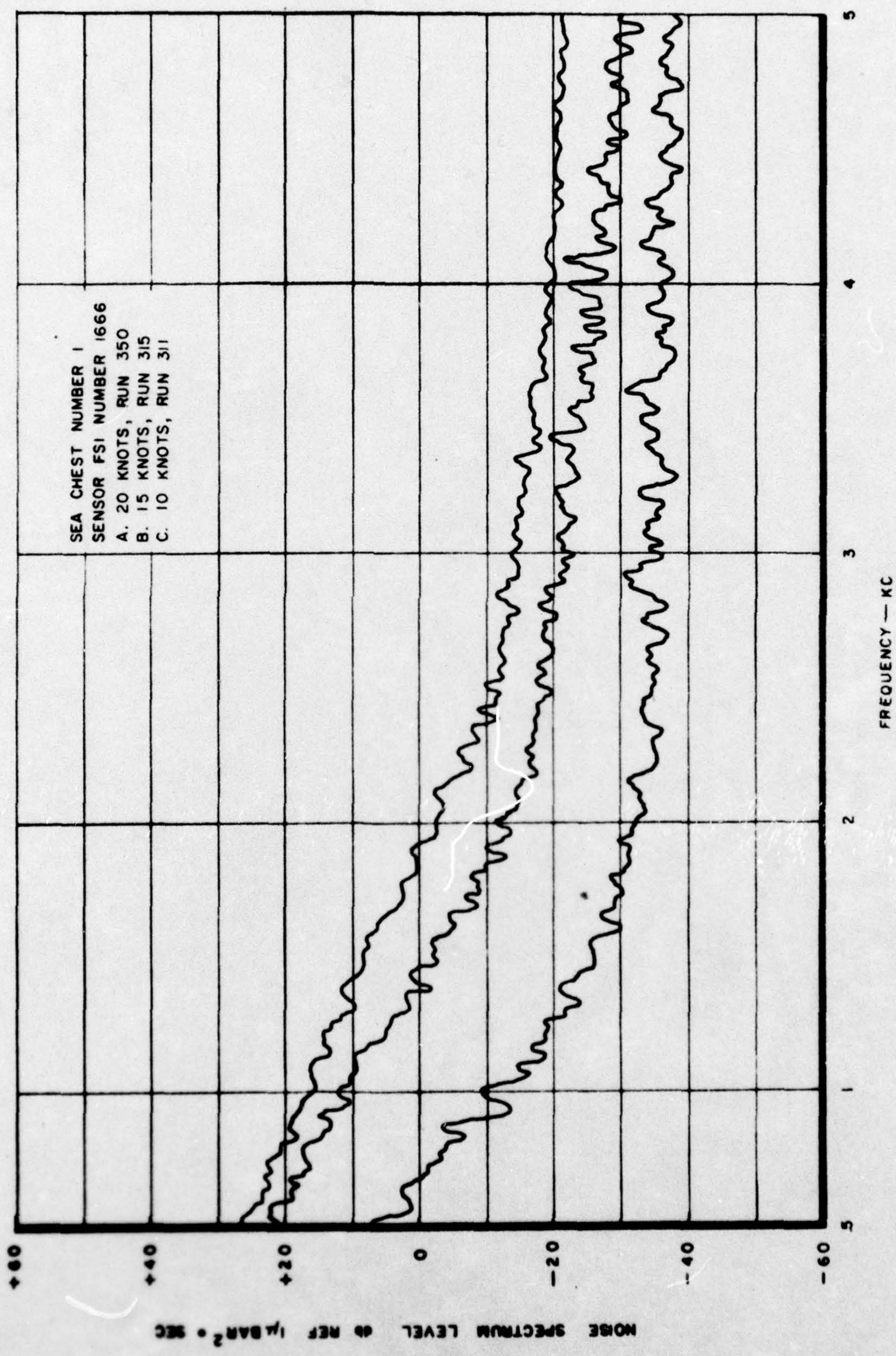


FIGURE 2-29

B026-47007(A)

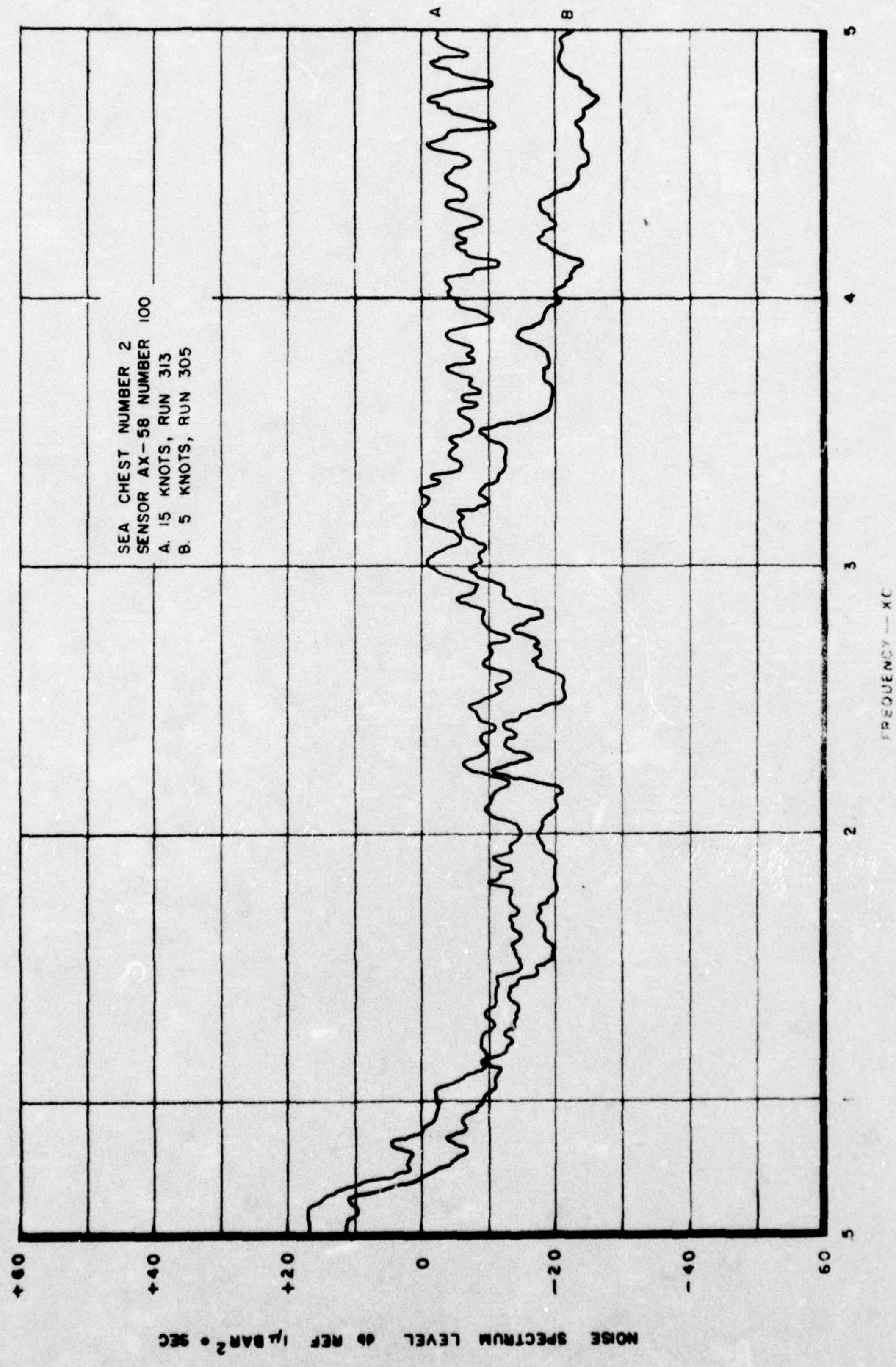


FIGURE 2-30

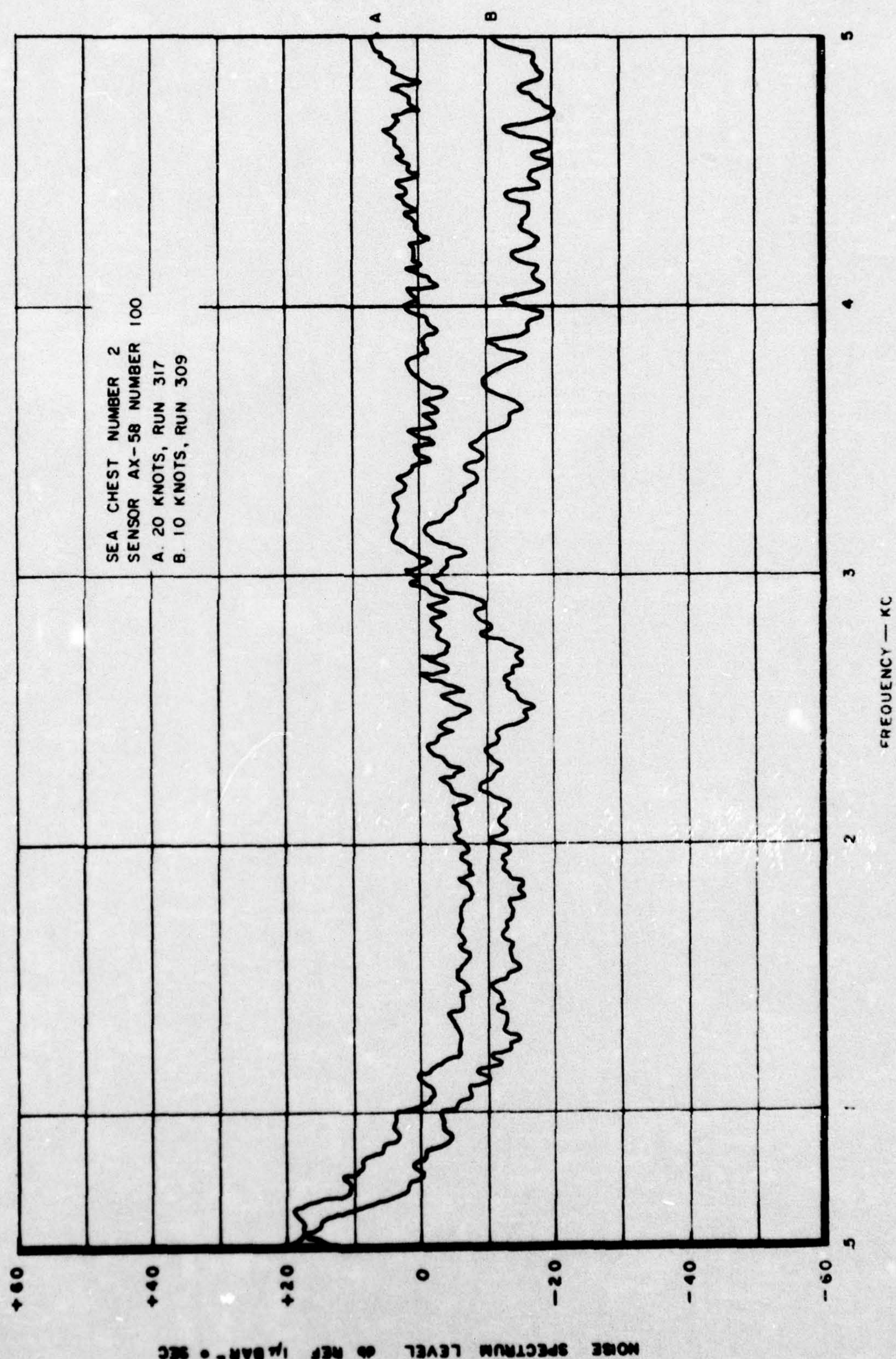

SEA CHEST NUMBER 2
SENSOR AX-58 NUMBER 100
A. 20 KNOTS, RUN 317
B. 10 KNOTS, RUN 309
A
B
+60
+40
+20
0
-20
-40
-60
NOISE SPECTRUM LEVEL db REF 1μBAR² • SEC
5
1
2
3
4
5
FREQUENCY — KC

FIGURE 2-31

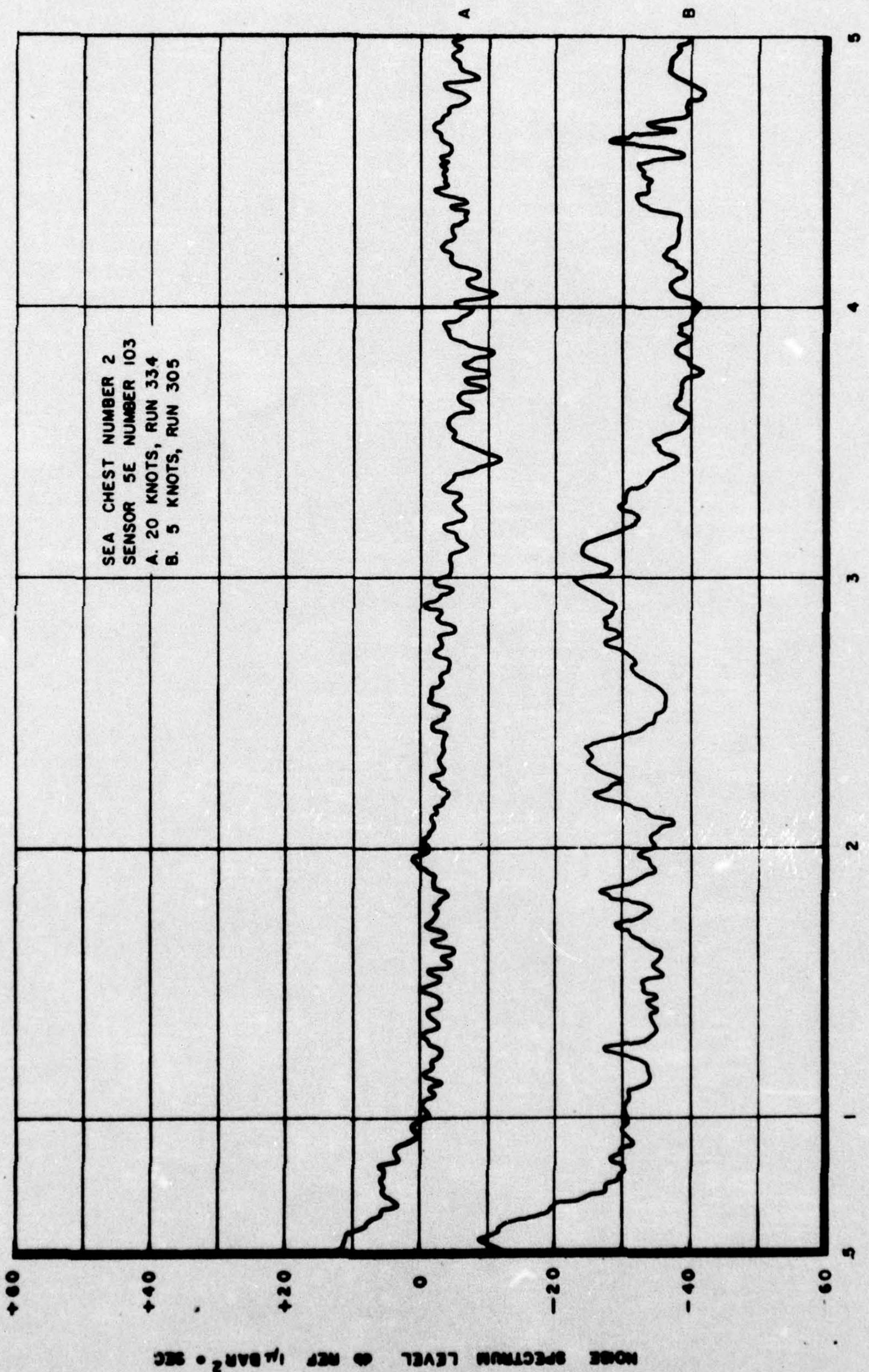

SEA CHEST NUMBER 2
SENSOR 5E NUMBER 103
A. 20 KNOTS, RUN 334
B. 5 KNOTS, RUN 305
A
B
FREQUENCY — KC

FIGURE 2-32

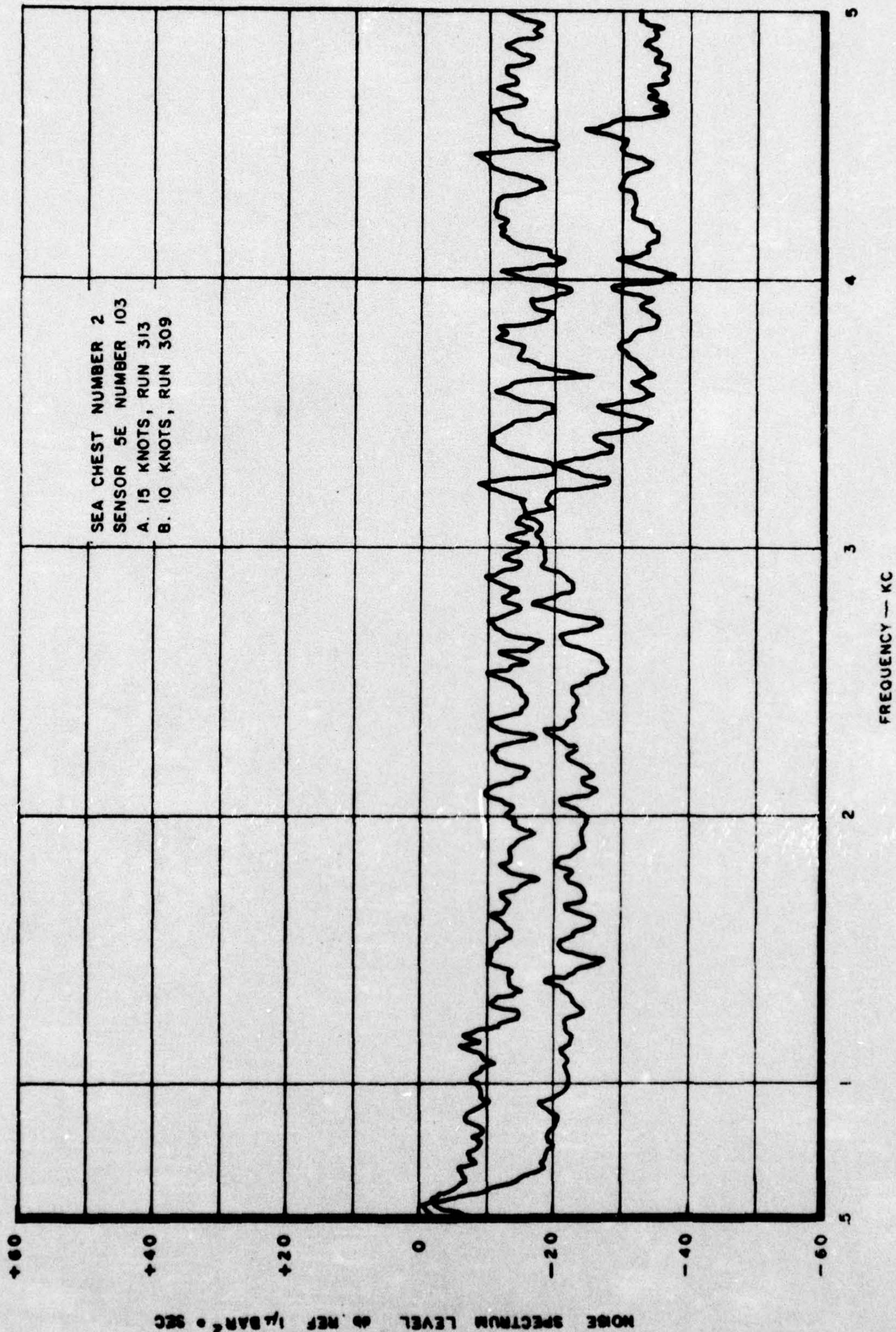

SEA CHEST NUMBER 2
SENSOR 5E NUMBER 103
A. 15 KNOTS, RUN 313
B. 10 KNOTS, RUN 309
FREQUENCY — KC
NOISE SPECTRUM LEVEL db REF 1/μBAR² • SEC
+60
+40
+20
0
-20
-40
-60
1
2
3
4
5

FIGURE 2-33

B026-47007 (A)

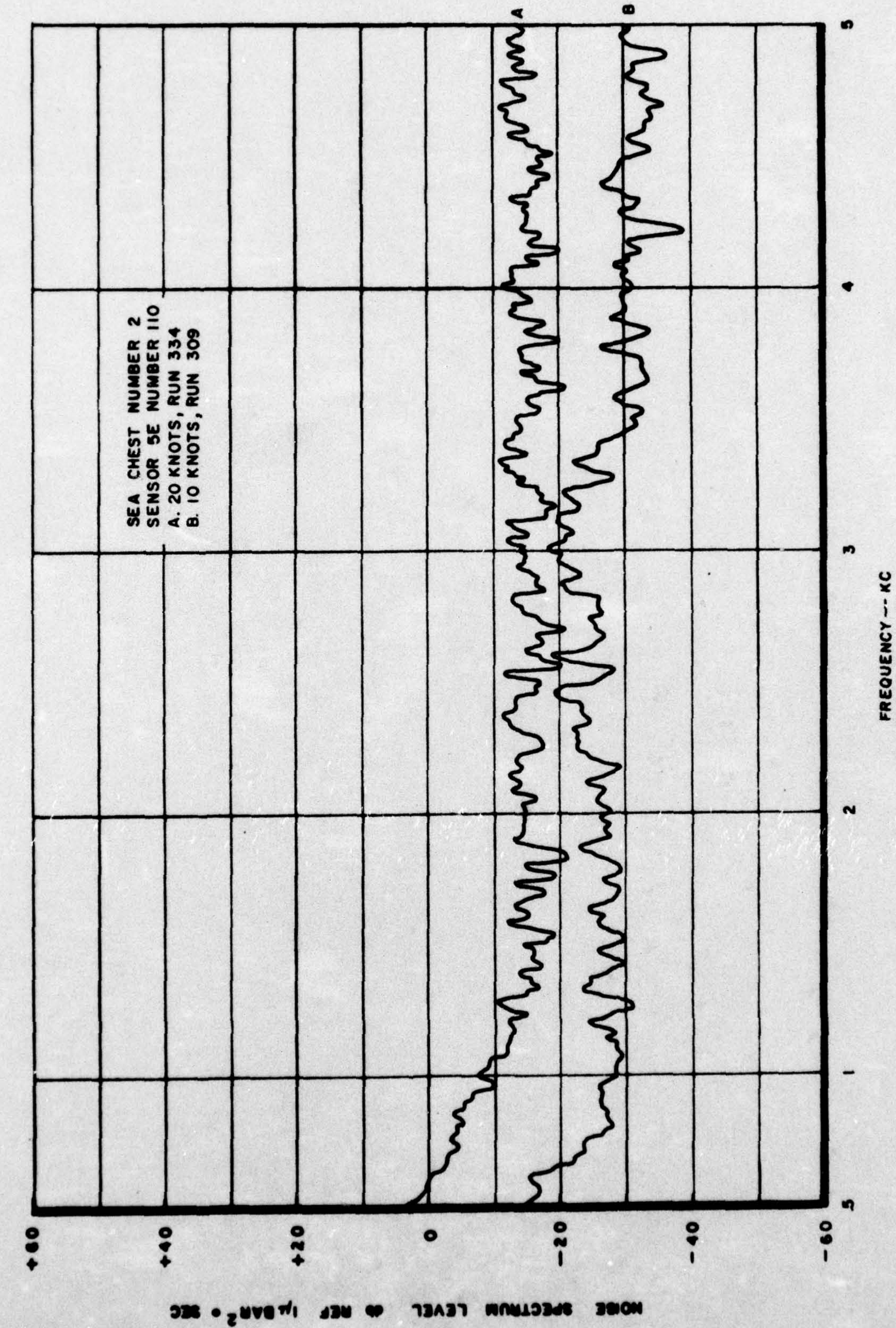


FIGURE 2-34

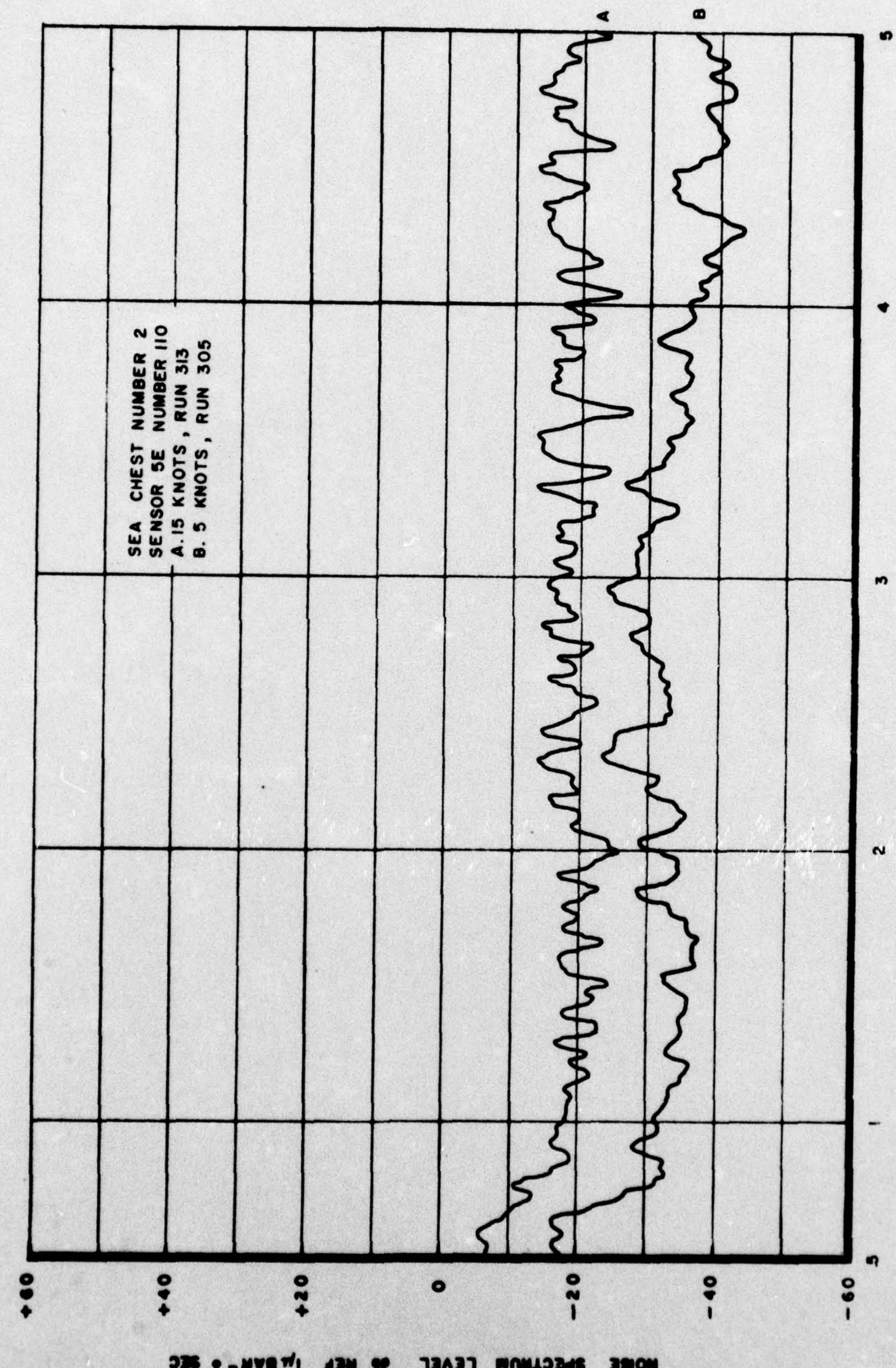

SEA CHEST NUMBER 2
SENSOR 5E NUMBER 110
A. 15 KNOTS, RUN 313
B. 5 KNOTS, RUN 305
A
B
+60
+40
+20
0
-20
-40
-60
NOISE SPECTRUM LEVEL db REF 1µBAR² • SEC
.5
1
2
3
4
5
FREQUENCY — KC

FIGURE 2-35

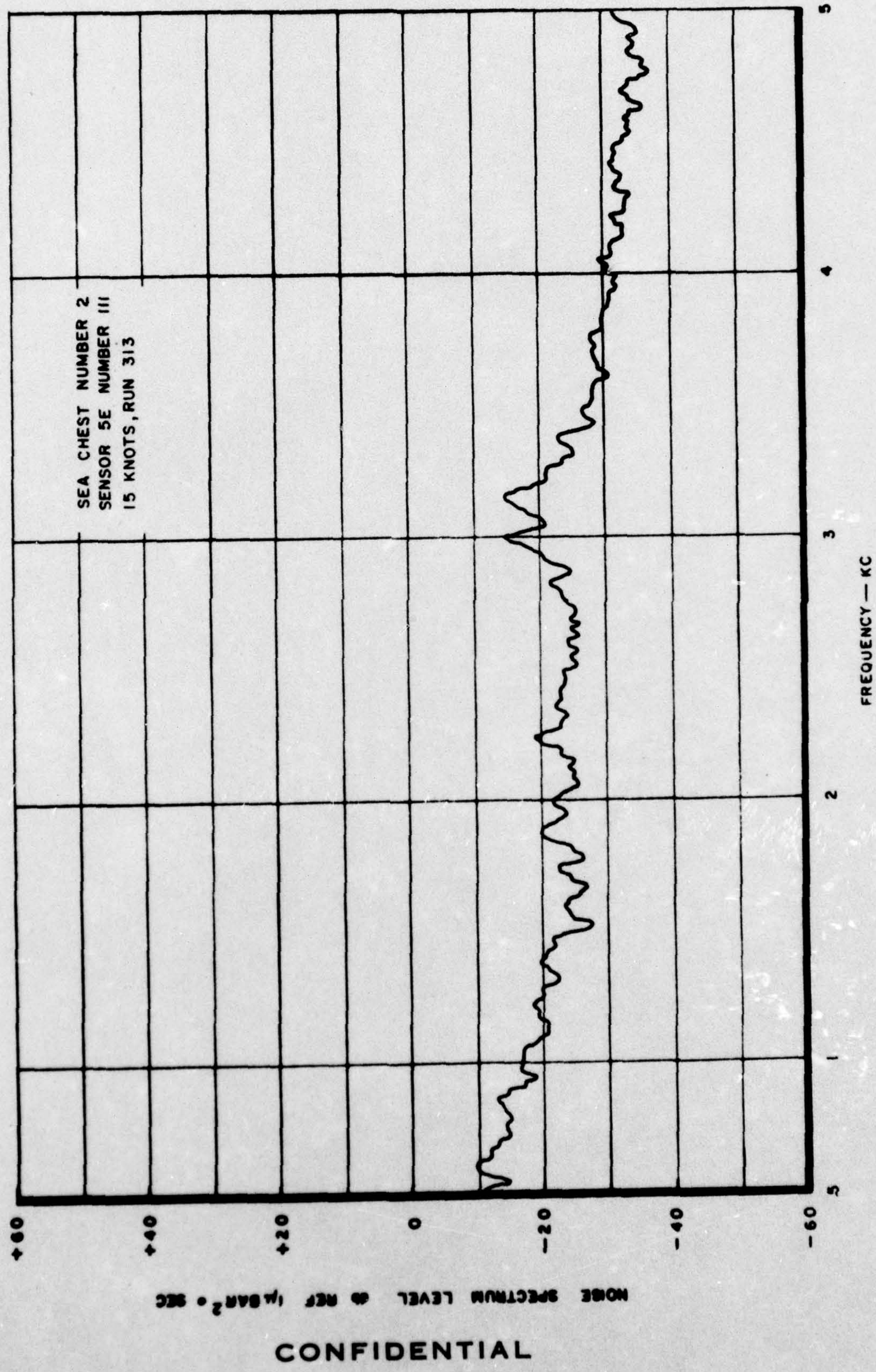

SEA CHEST NUMBER 2
SENSOR 5E NUMBER 111
15 KNOTS, RUN 313
+60
+40
+20
0
-20
-40
-60
NOISE SPECTRUM LEVEL db REF 1μBAR²· SEC
5
1
2
3
4
5
FREQUENCY — KC

FIGURE 2-36

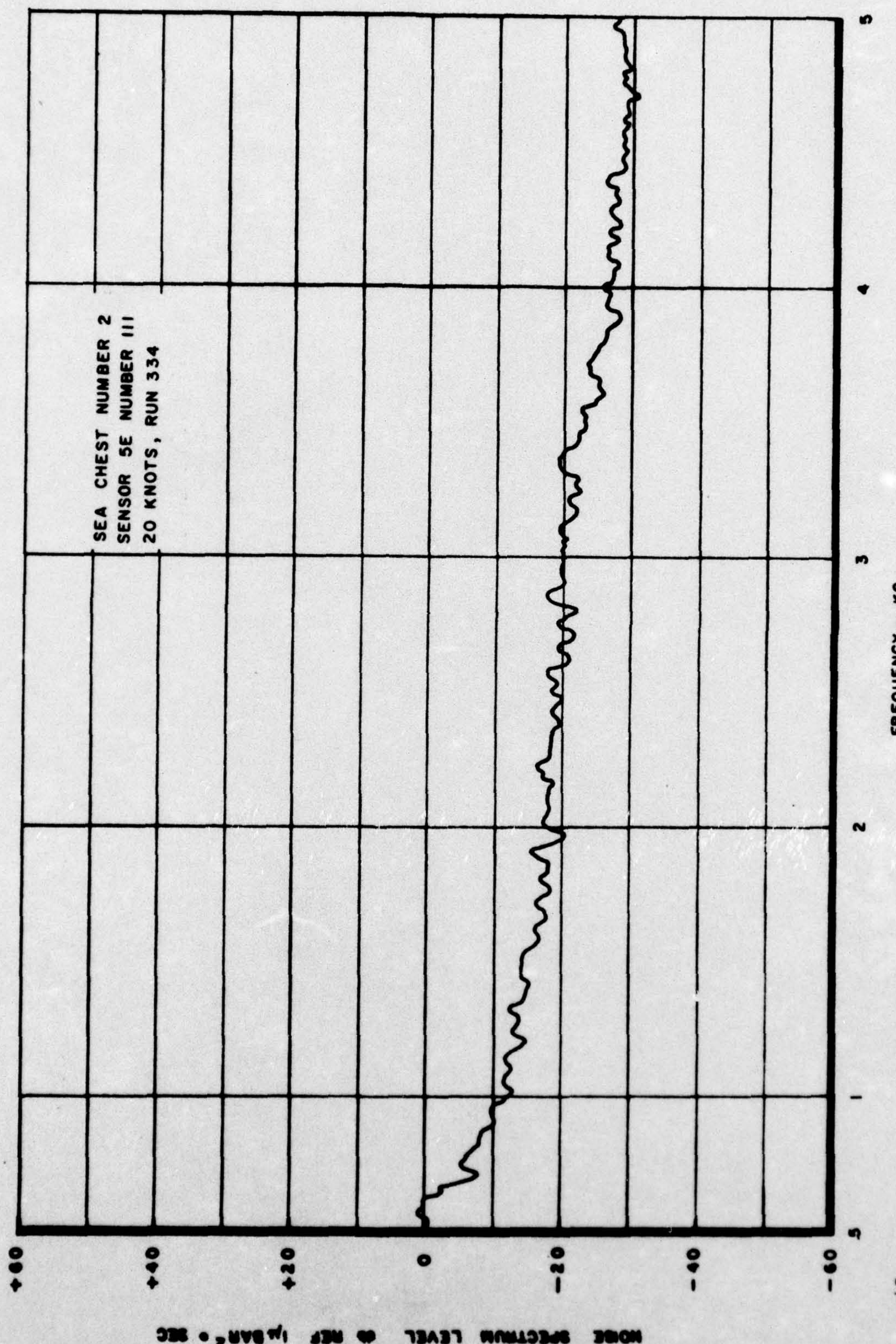

SEA CHEST NUMBER 2
SENSOR 5E NUMBER III
20 KNOTS, RUN 334
FREQUENCY — KC
.5
1
2
3
4
5
+60
+40
+20
0
-20
-40
-60

FIGURE 2-37

CONFIDENTIAL

B026-47007(A)

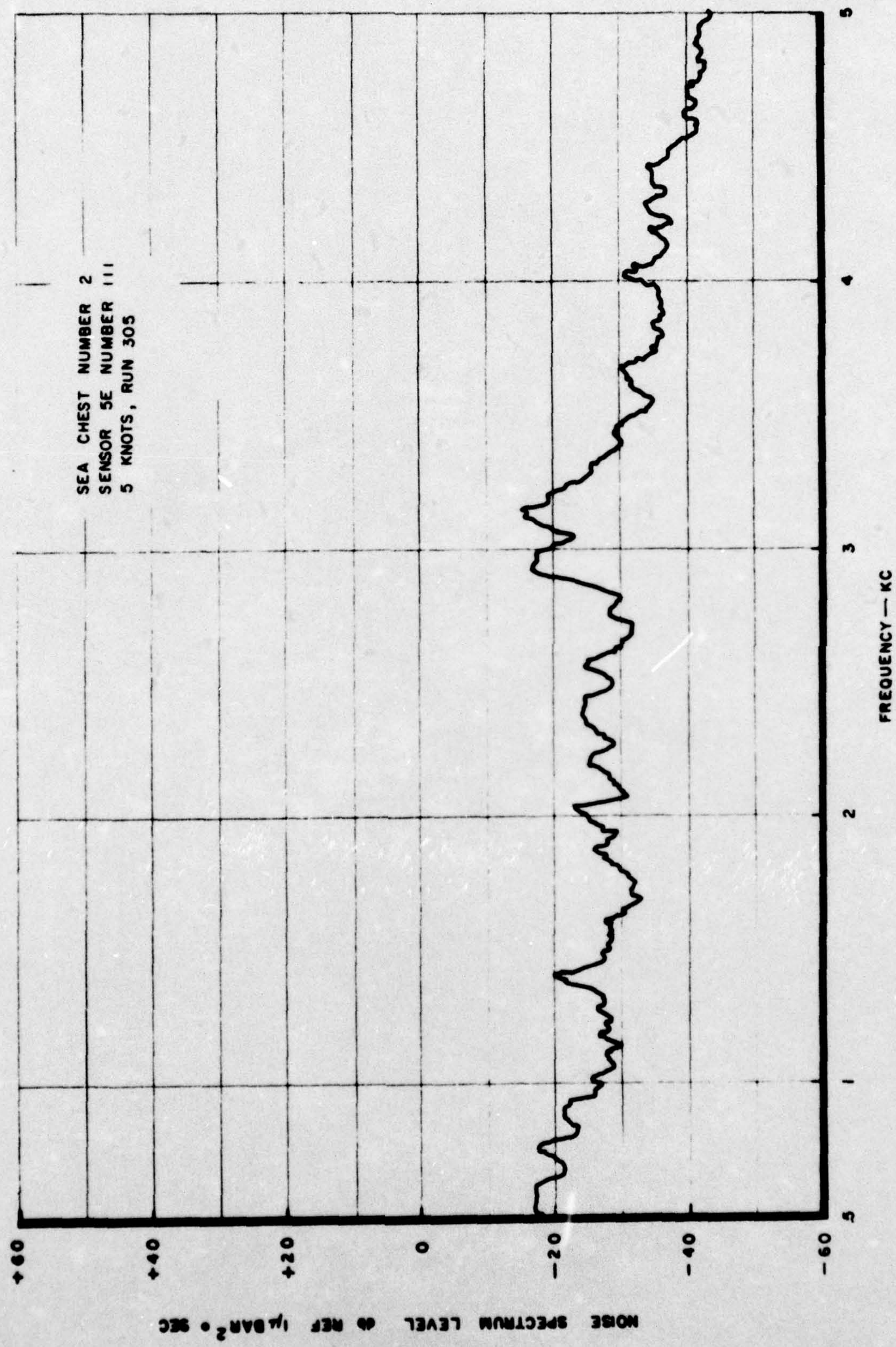


FIGURE 2-38

CONFIDENTIAL

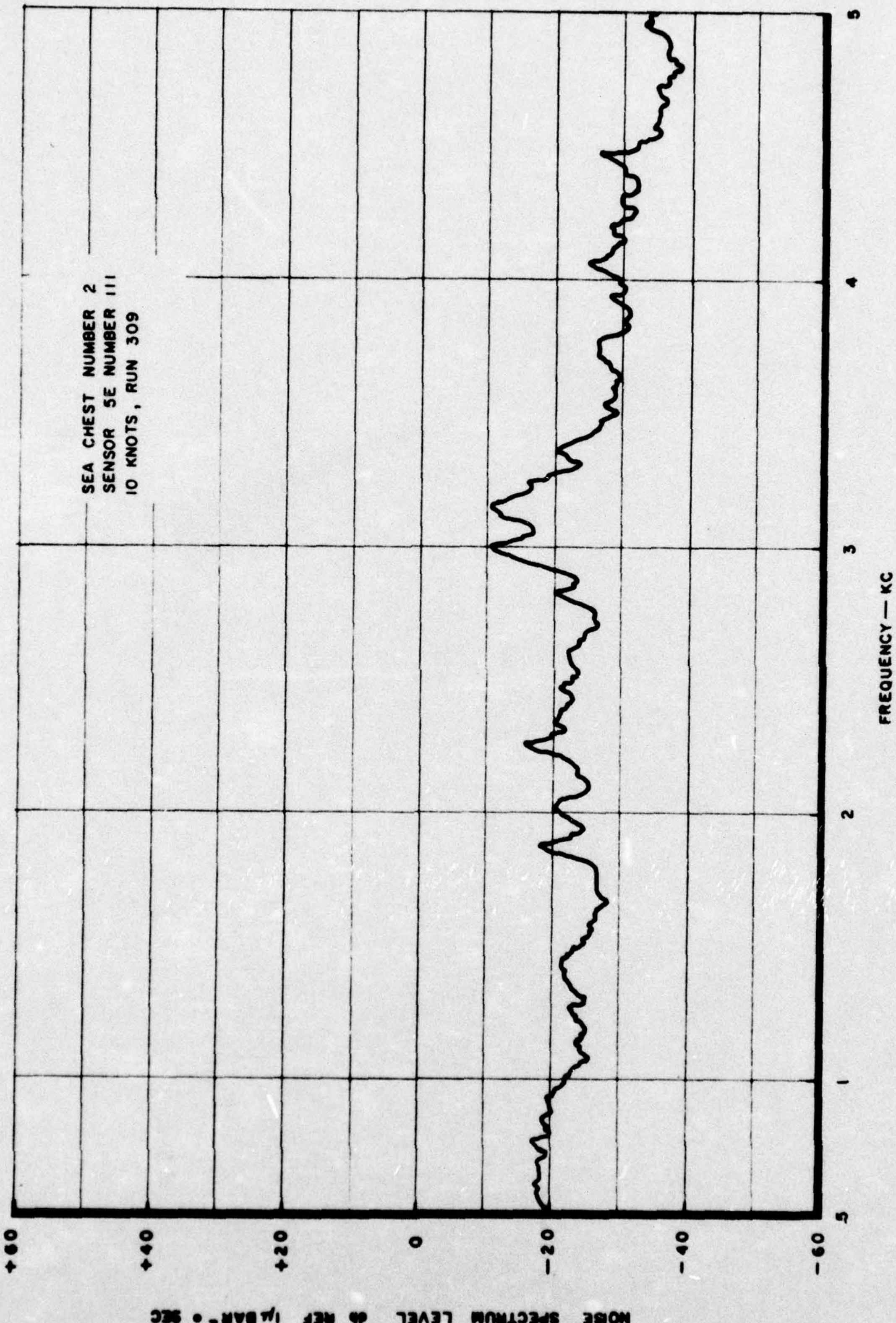

SEA CHEST NUMBER 2
SENSOR 5E NUMBER 111
10 KNOTS, RUN 309
NOISE SPECTRUM LEVEL db REF 1μBAR² • SEC
+60
+40
+20
0
-20
-40
-60
FREQUENCY — KC
.5
1
2
3
4
5

FIGURE 2-39

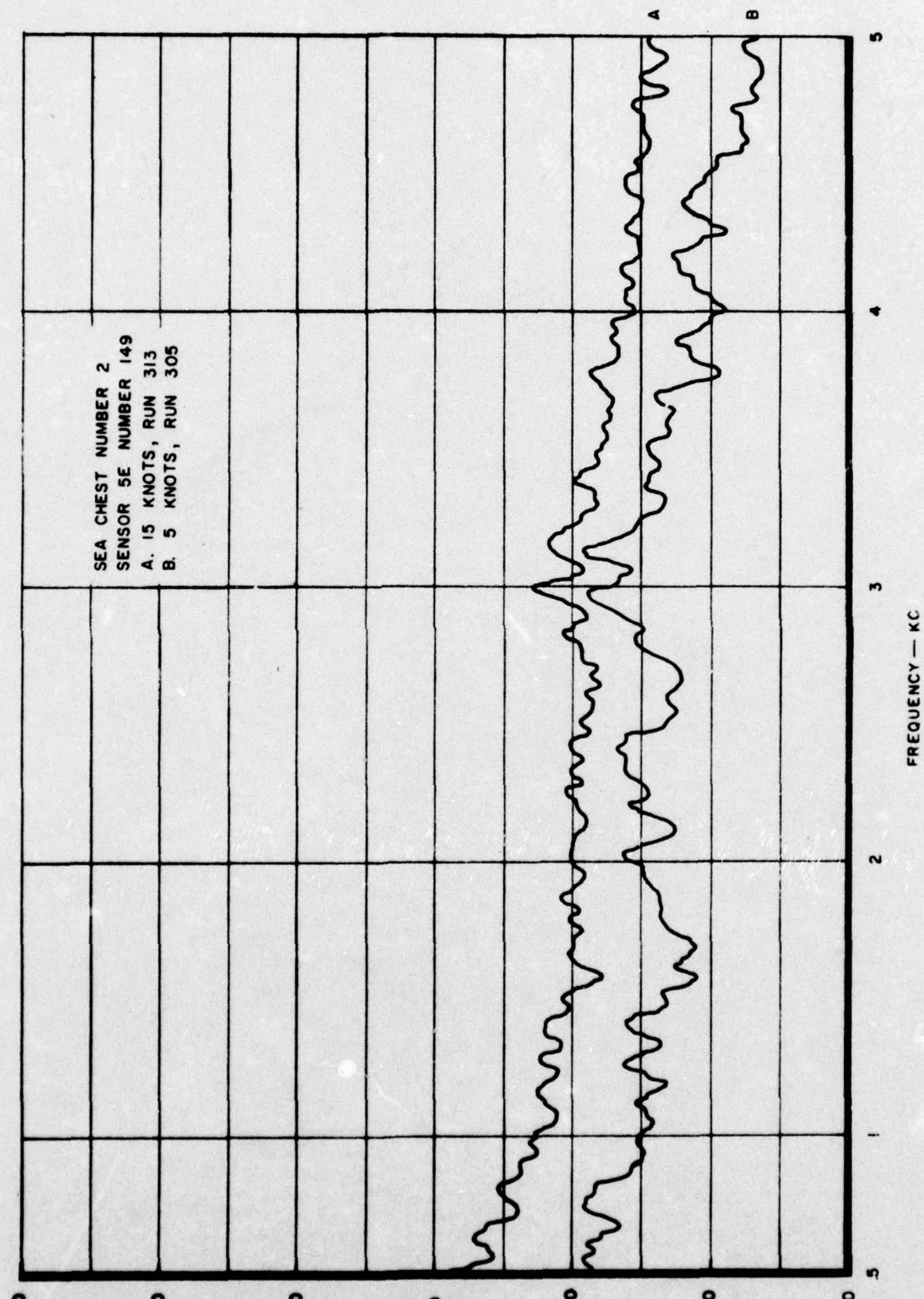

SEA CHEST NUMBER 2
SENSOR 5E NUMBER 149
A. 15 KNOTS, RUN 313
B. 5 KNOTS, RUN 305
A
B
+60
+40
+20
0
-20
-40
-60
NOISE SPECTRUM LEVEL db REF 1 µBAR² • SEC
5
1
2
3
4
5
FREQUENCY — KC

FIGURE 2-40

B026-47007(A)

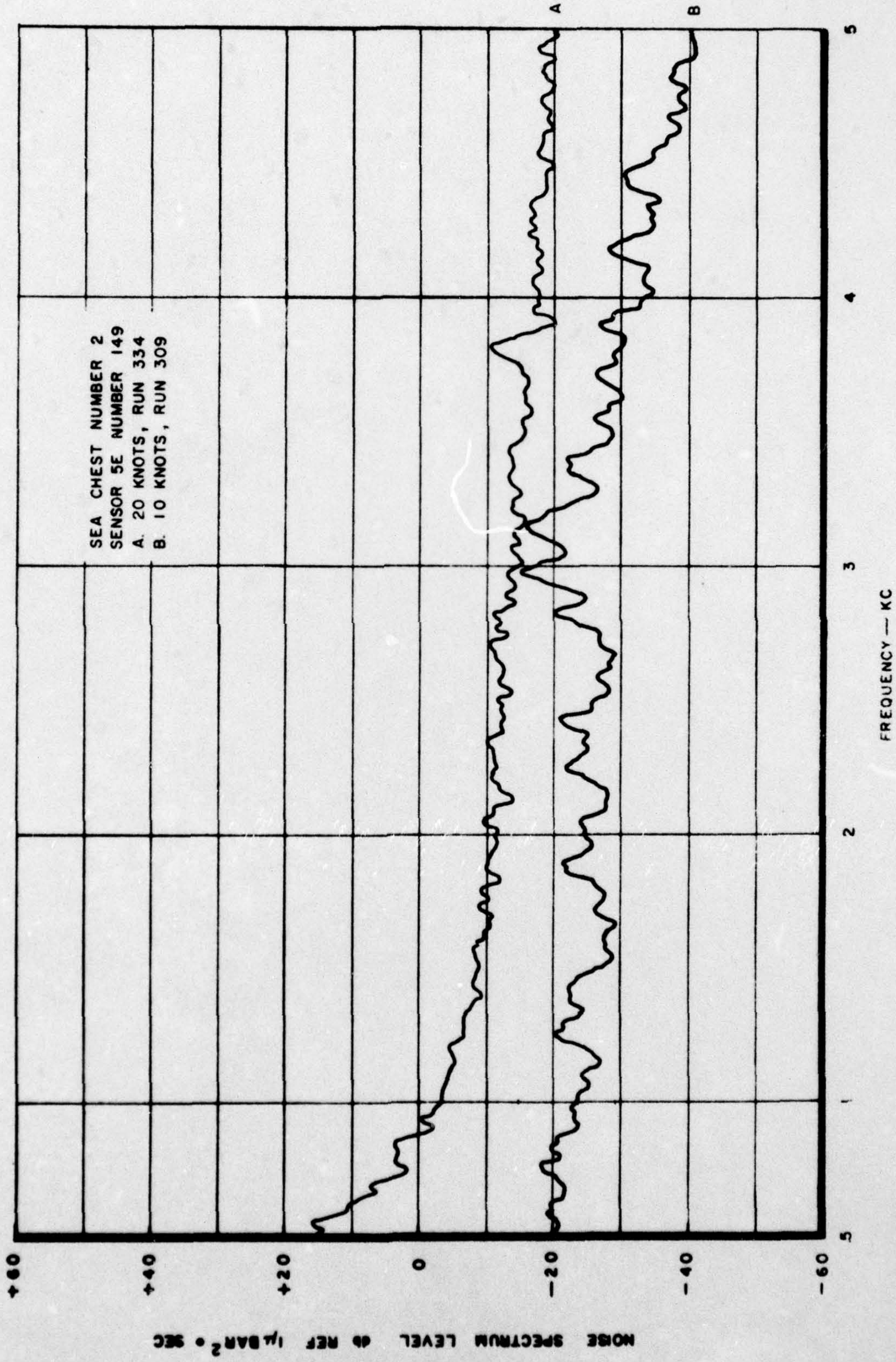


FIGURE 2-41

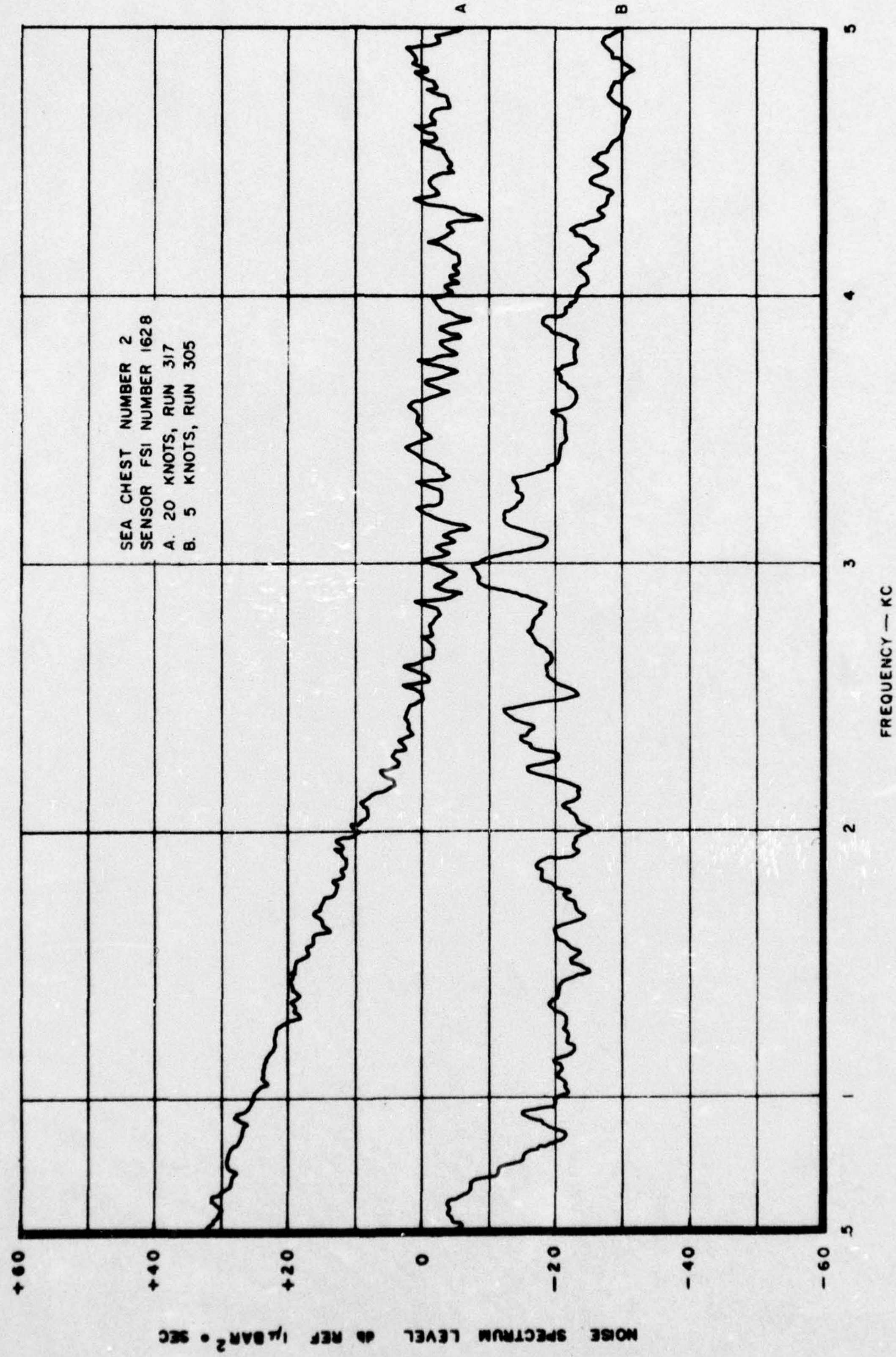

SEA CHEST NUMBER 2
SENSOR FSI NUMBER 1628
A. 20 KNOTS, RUN 317
B. 5 KNOTS, RUN 305
A
B
+60
+40
+20
0
-20
-40
-60
NOISE SPECTRUM LEVEL db REF 1μBAR² • SEC
.5
1
2
3
4
5
FREQUENCY — KC

FIGURE 2-42

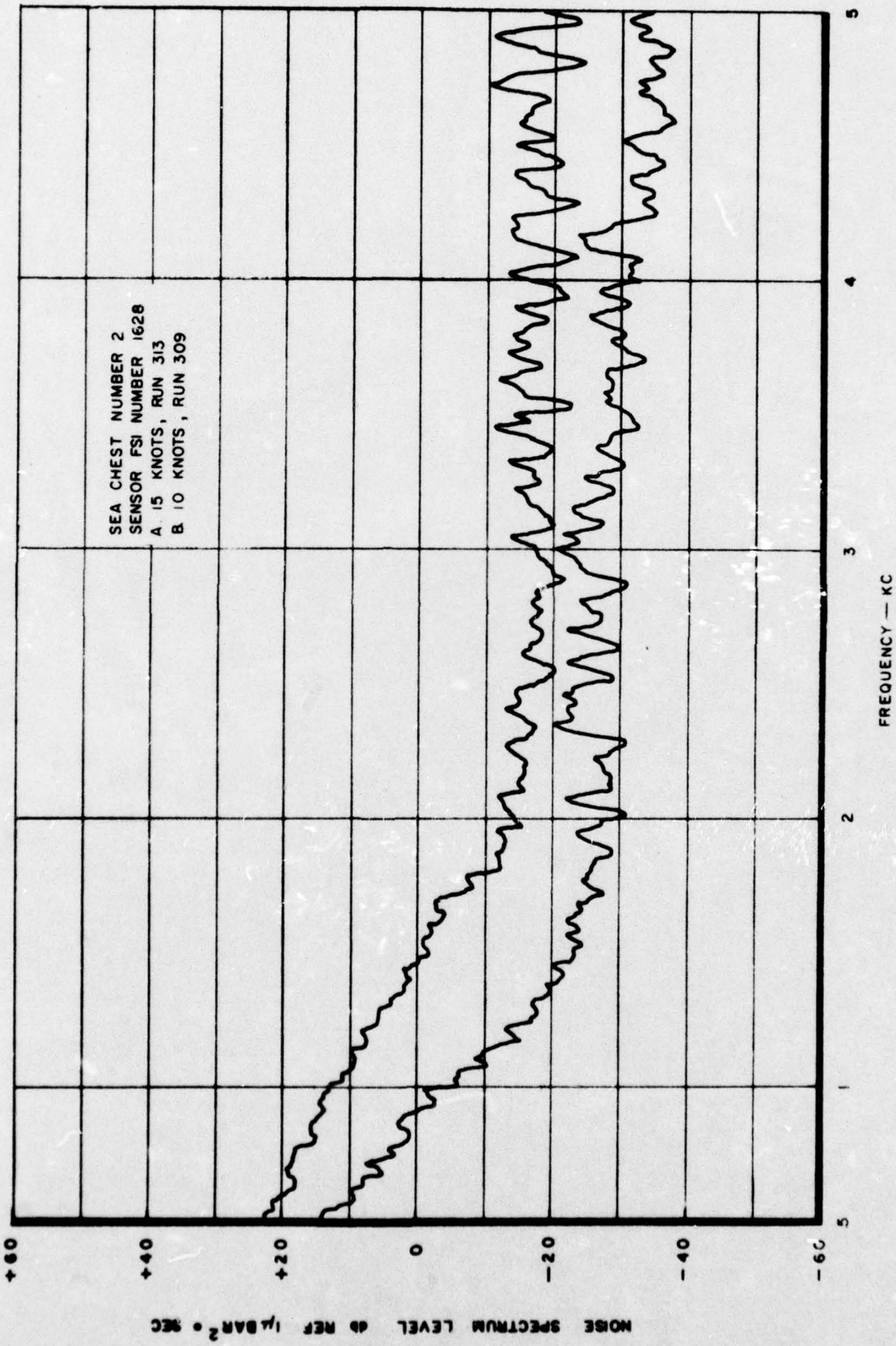

SEA CHEST NUMBER 2
SENSOR FSI NUMBER 1628
A 15 KNOTS, RUN 313
B. 10 KNOTS, RUN 309
A
B
+60
+40
+20
0
-20
-40
-60
5
1
2
3
4
5
FREQUENCY — KC
NOISE SPECTRUM LEVEL db REF 1μBAR² • SEC

FIGURE 2-43

B026-47007(A)

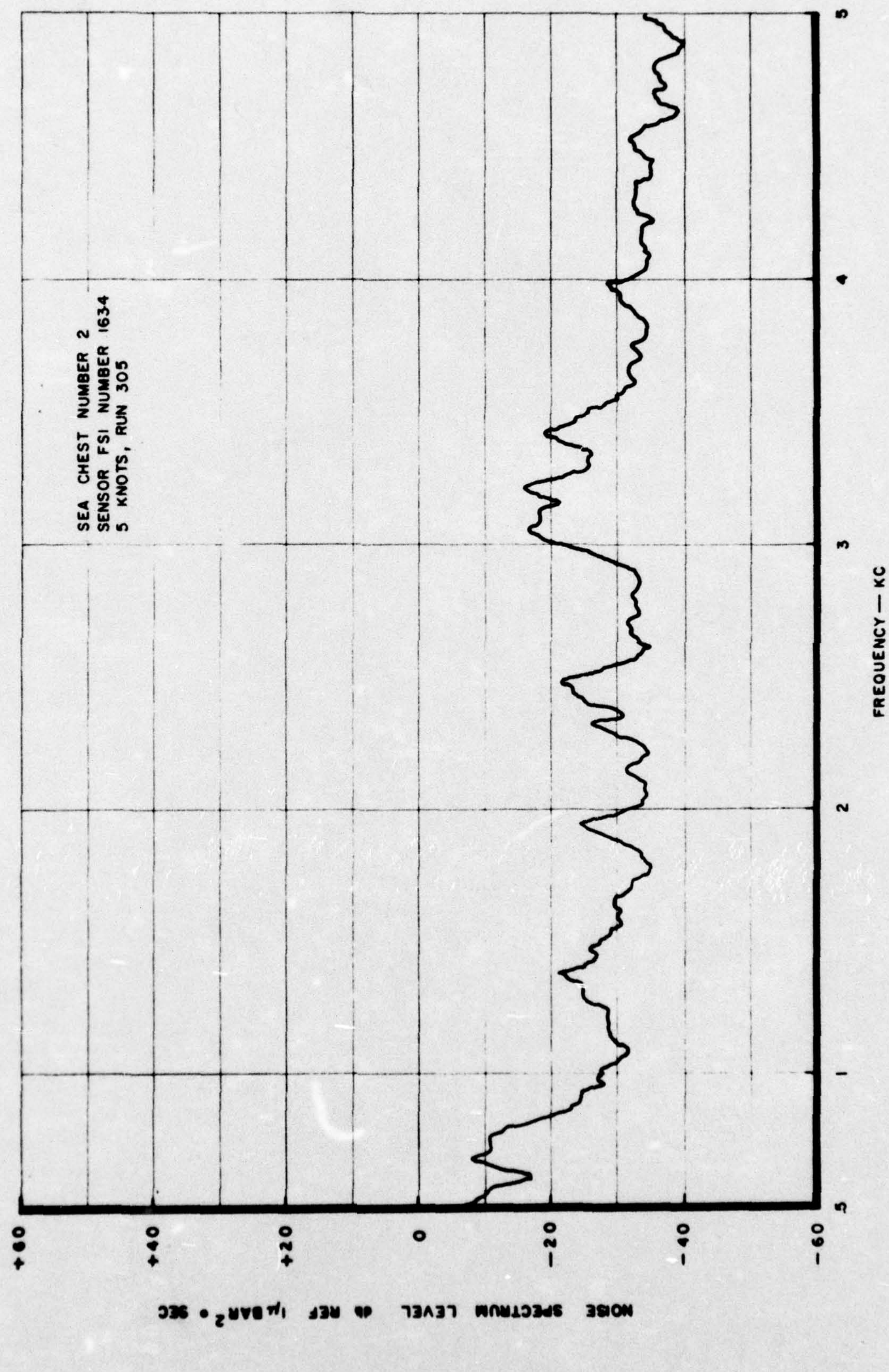


FIGURE 2-44

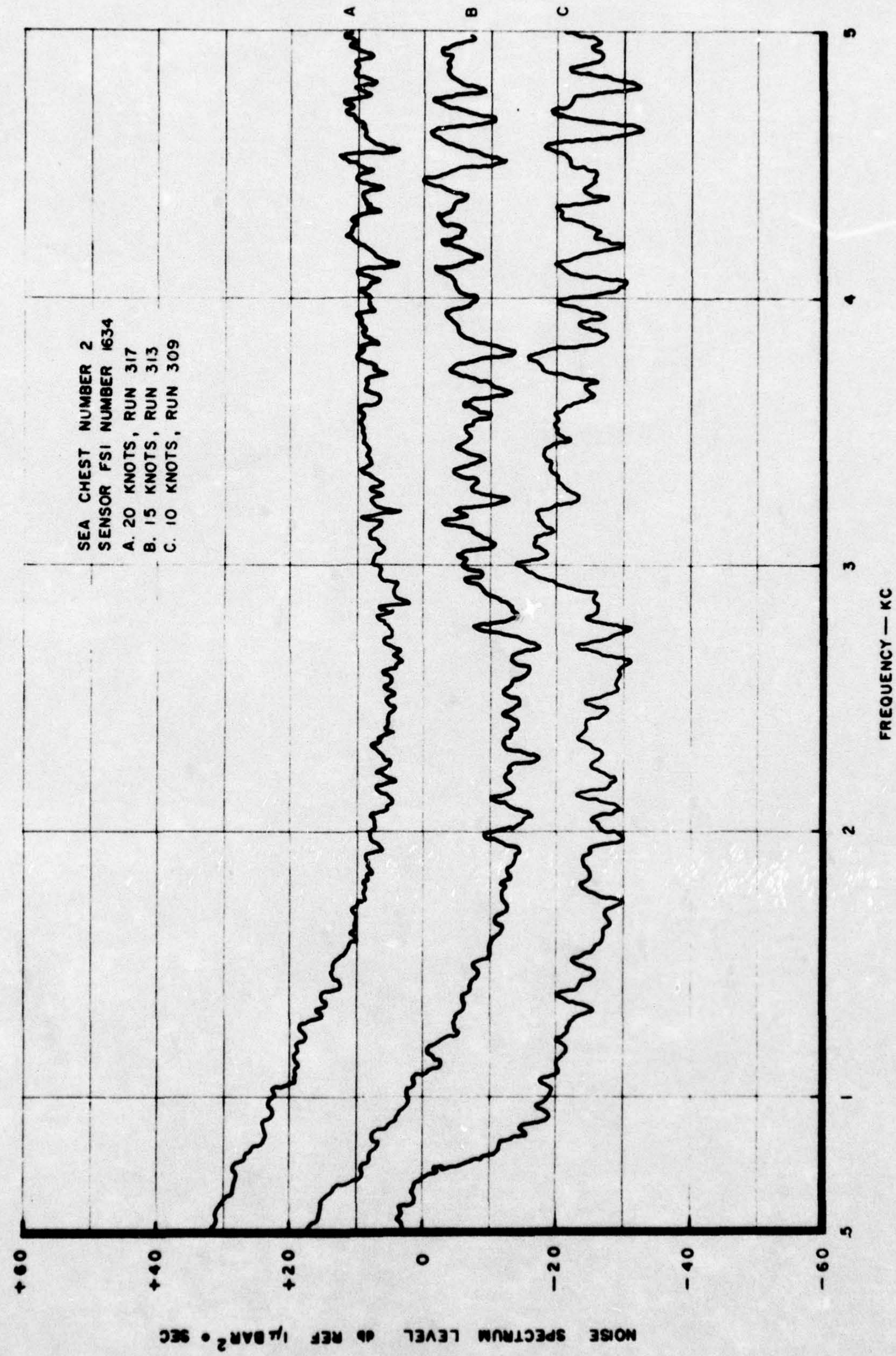

SEA CHEST NUMBER 2
SENSOR FSI NUMBER 1634
A. 20 KNOTS, RUN 317
B. 15 KNOTS, RUN 313
C. 10 KNOTS, RUN 309
A
B
C
+60
+40
+20
0
−20
−40
−60
NOISE SPECTRUM LEVEL db REF 1 μBAR² • SEC
.5
1
2
3
4
5
FREQUENCY — KC

FIGURE 2-45

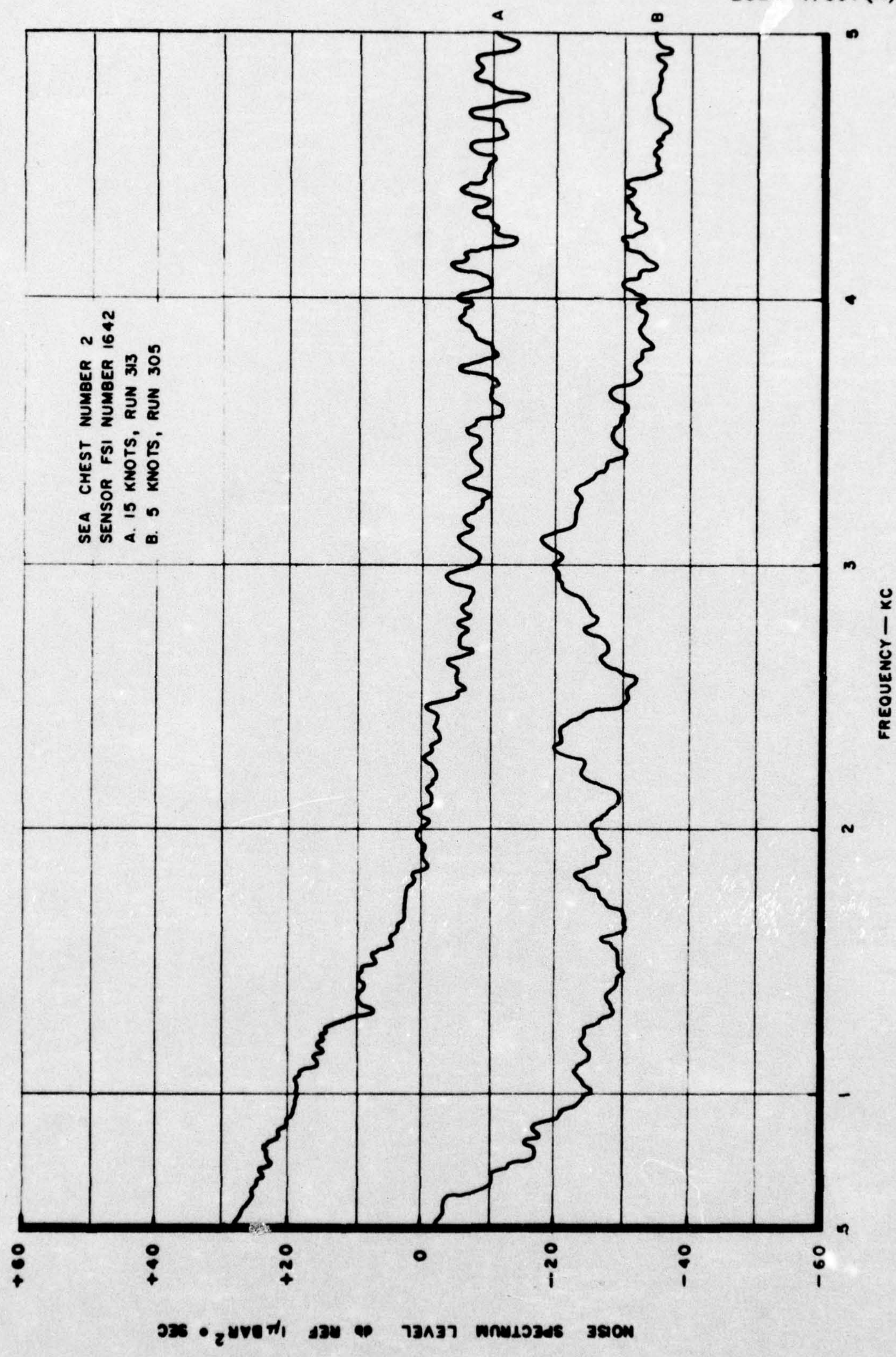

SEA CHEST NUMBER 2
SENSOR FSI NUMBER 1642
A. 15 KNOTS, RUN 313
B. 5 KNOTS, RUN 305
A
B
+60
+40
+20
0
-20
-40
-60
NOISE SPECTRUM LEVEL db REF 1 μBAR² • SEC
5
1
2
3
4
5
FREQUENCY — KC

FIGURE 2-46

B026-47007 (A)

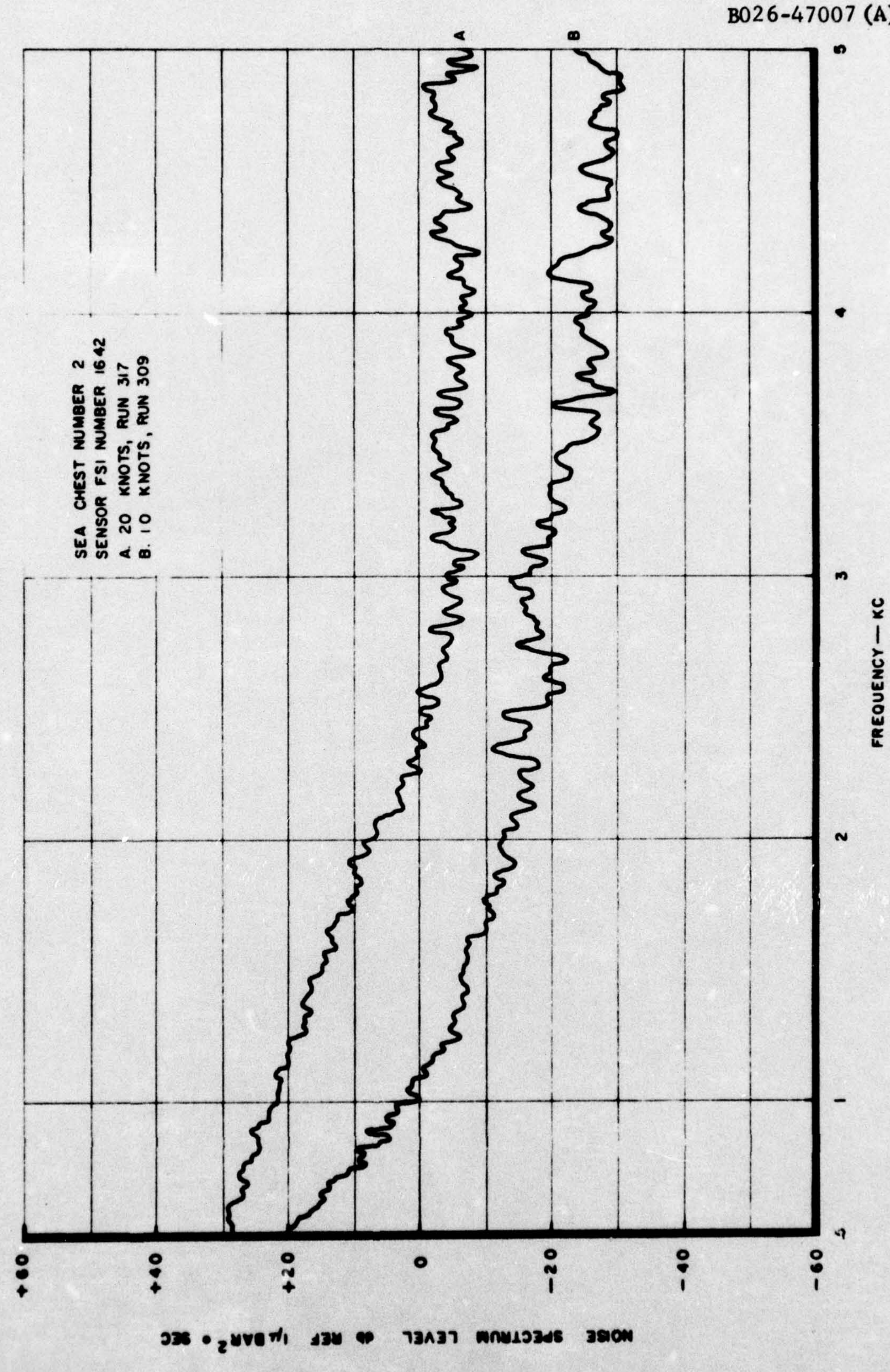


FIGURE 2-47

B026-47007 (A)

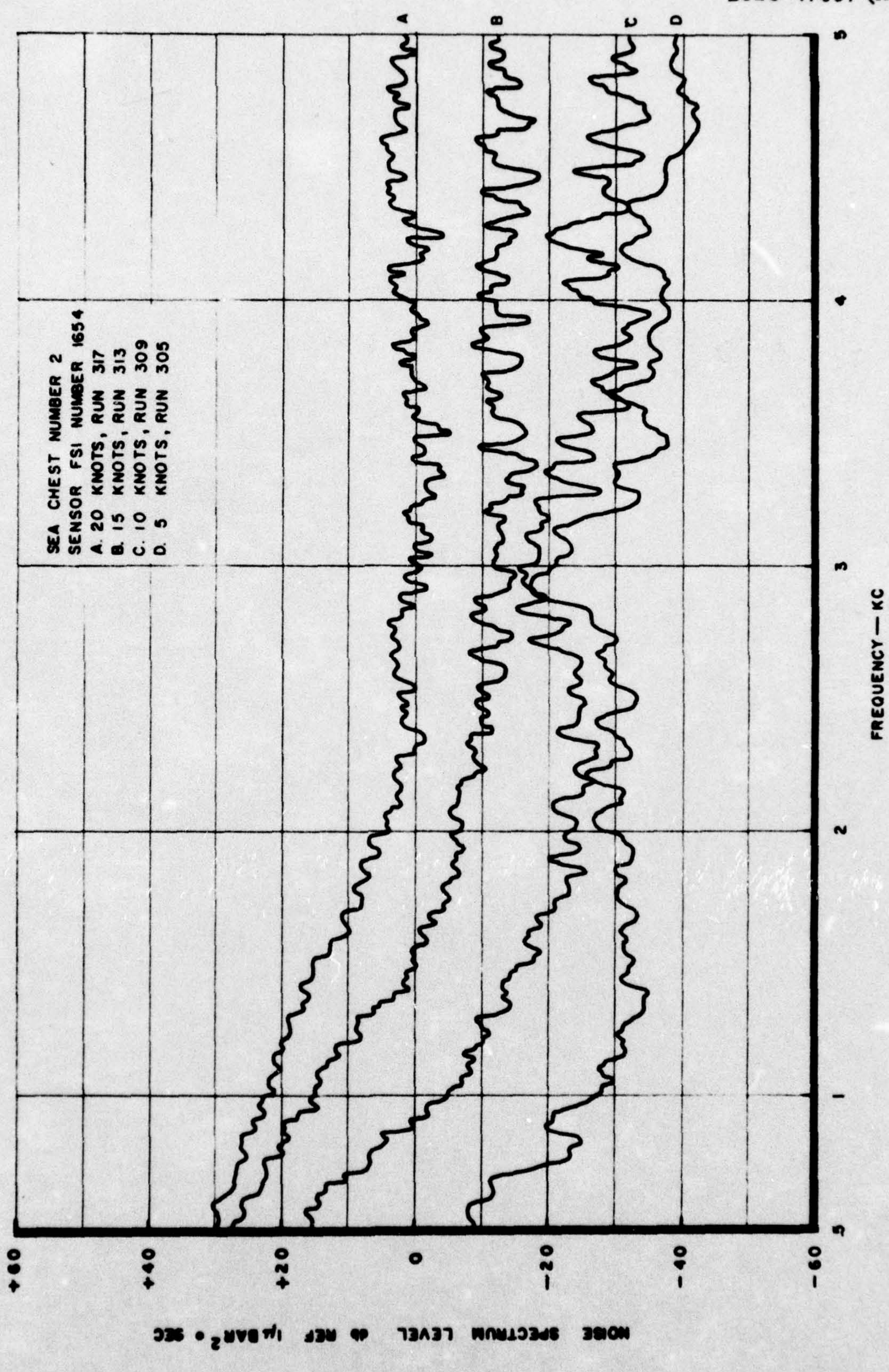


FIGURE 2-48

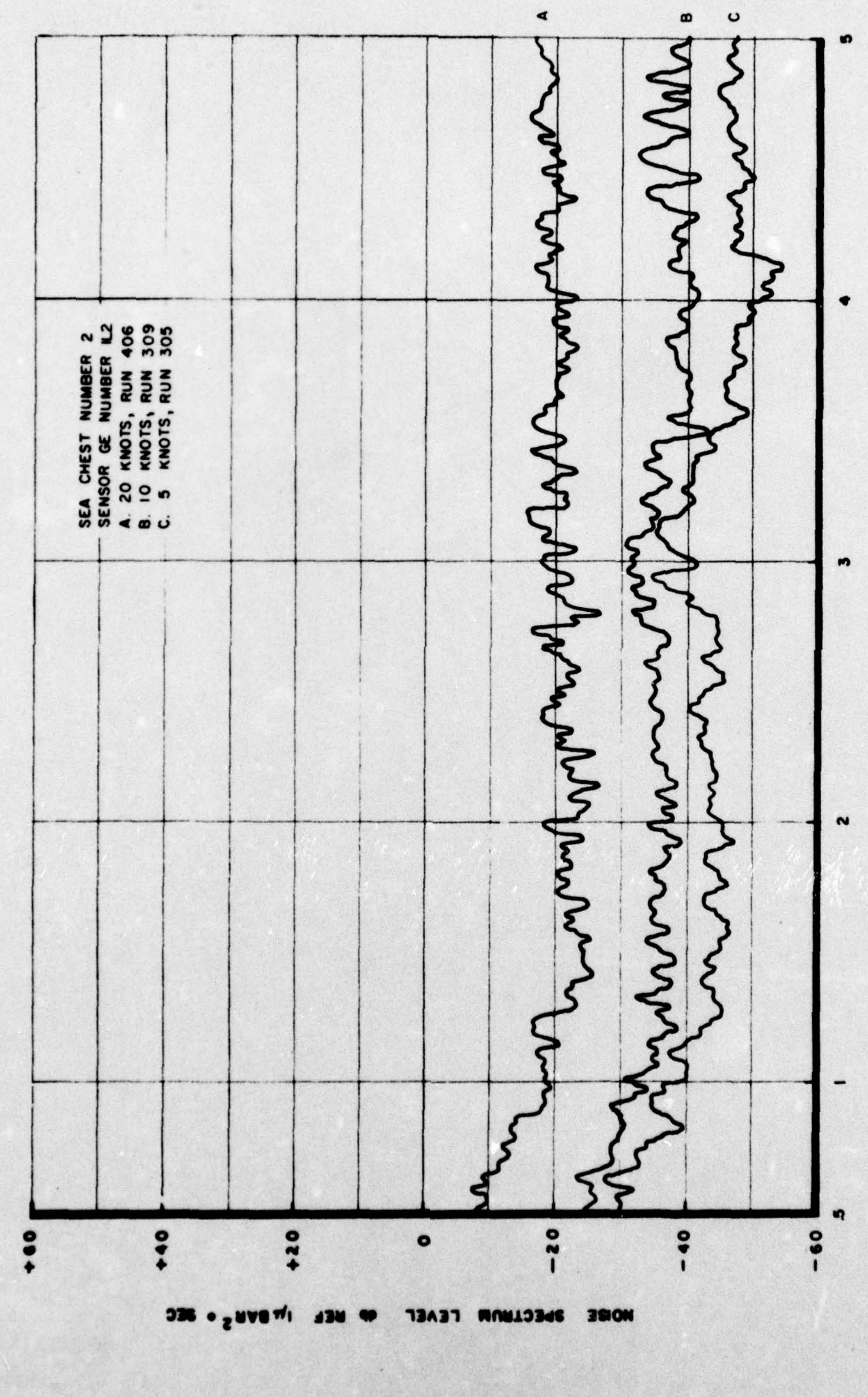

SEA CHEST NUMBER 2
SENSOR GE NUMBER L2
A. 20 KNOTS, RUN 406
B. 10 KNOTS, RUN 309
C. 5 KNOTS, RUN 305
A
B
C
.5
1
2
3
4
5
FREQUENCY — KC
+60
+40
+20
0
-20
-40
-60
NOISE SPECTRUM LEVEL db REF 1μBAR² • SEC

FIGURE 2-49

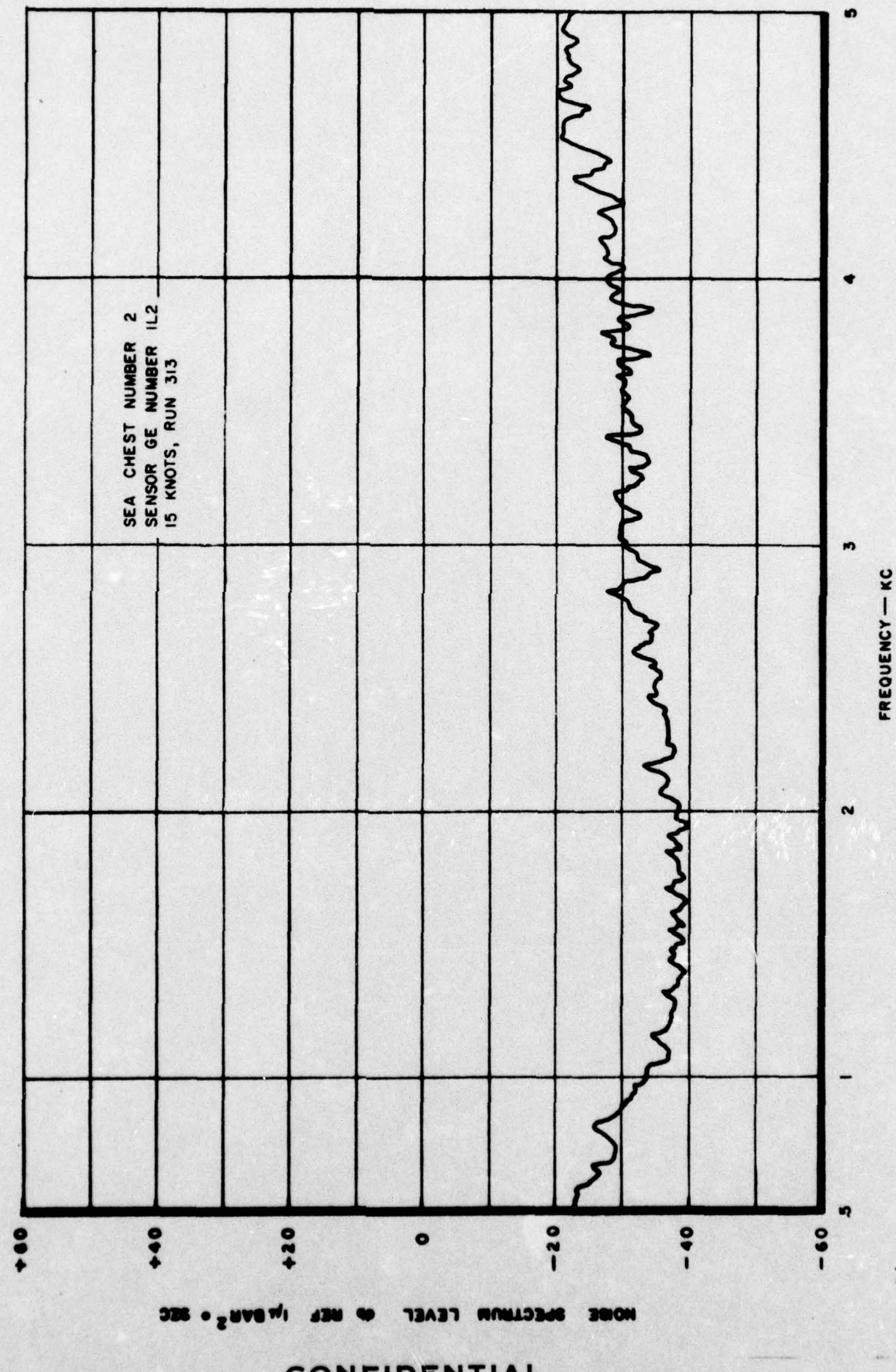

SEA CHEST NUMBER 2
SENSOR GE NUMBER IL2
15 KNOTS, RUN 313
FREQUENCY — KC
5
1
2
3
4
5
+60
+40
+20
0
-20
-40
-60
NOISE SPECTRUM LEVEL db REF 1μBAR² • SEC

FIGURE 2-50

B026-47007(A)

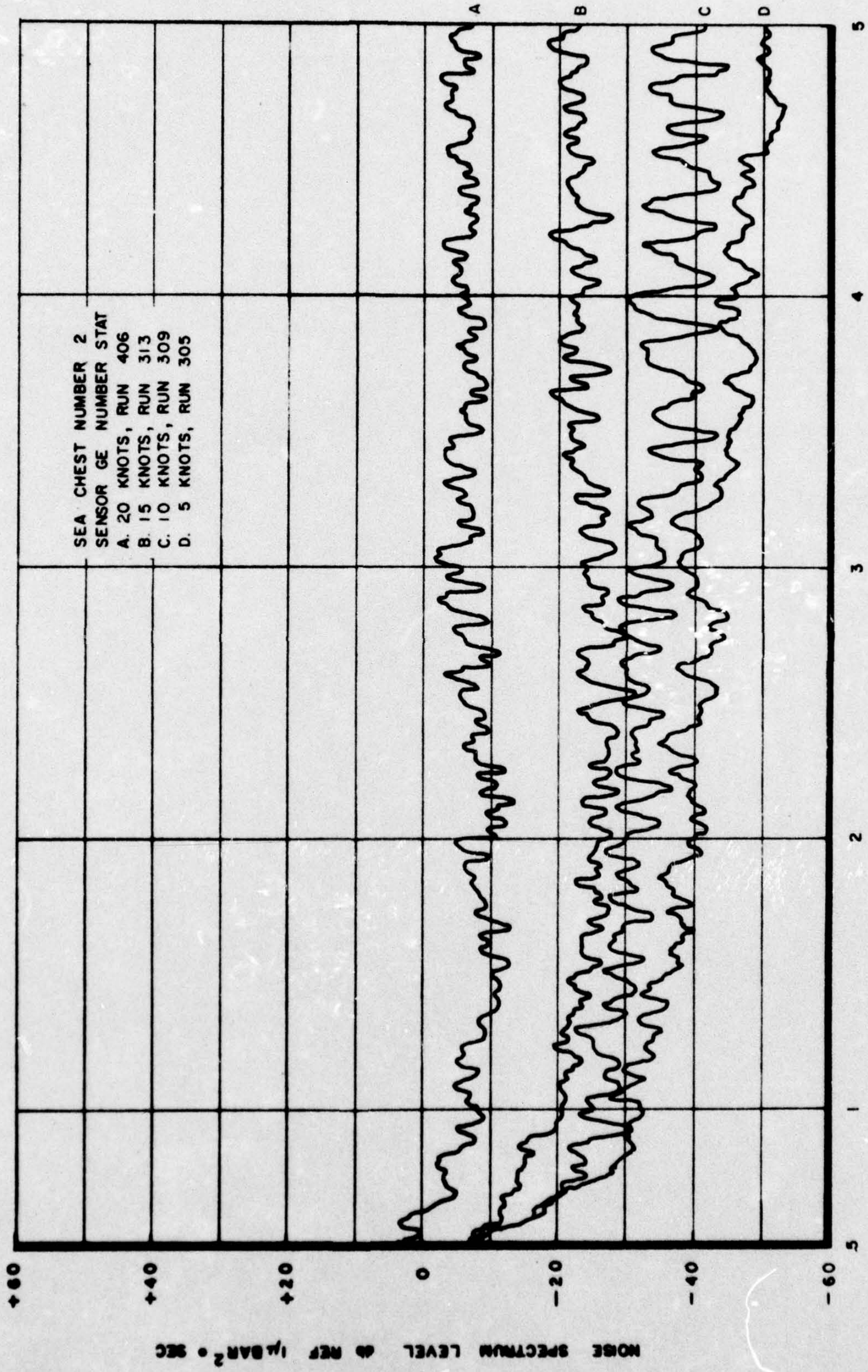


FIGURE 2-51

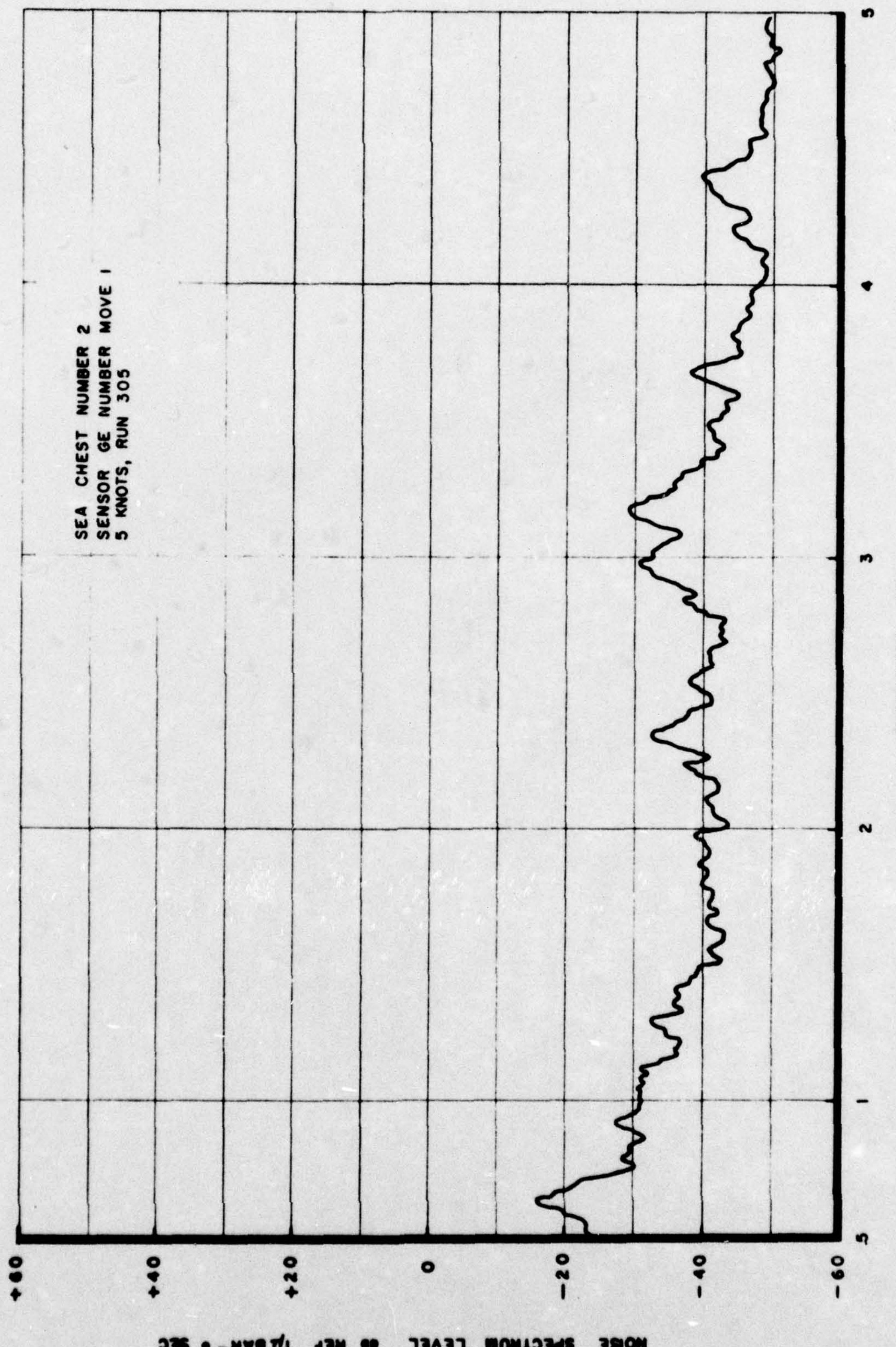

SEA CHEST NUMBER 2
SENSOR GE NUMBER MOVE I
5 KNOTS, RUN 305
NOISE SPECTRUM LEVEL db REF 1 μBAR² • SEC
+60
+40
+20
0
-20
-40
-60
.5
1
2
3
4
5
FREQUENCY — KC

FIGURE 2-53

B026-47007(A)

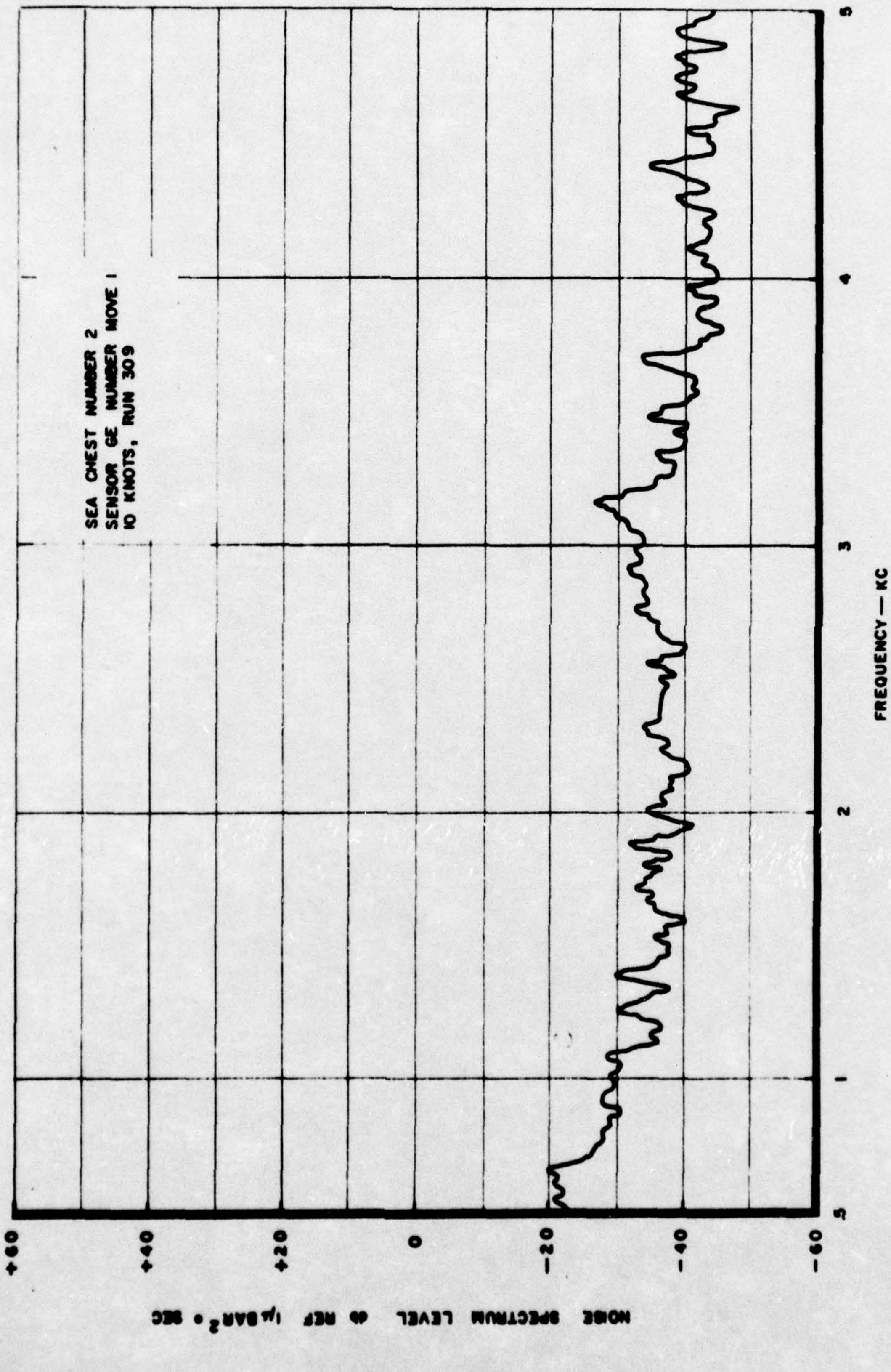


FIGURE 2-54

B026-47007 (A)

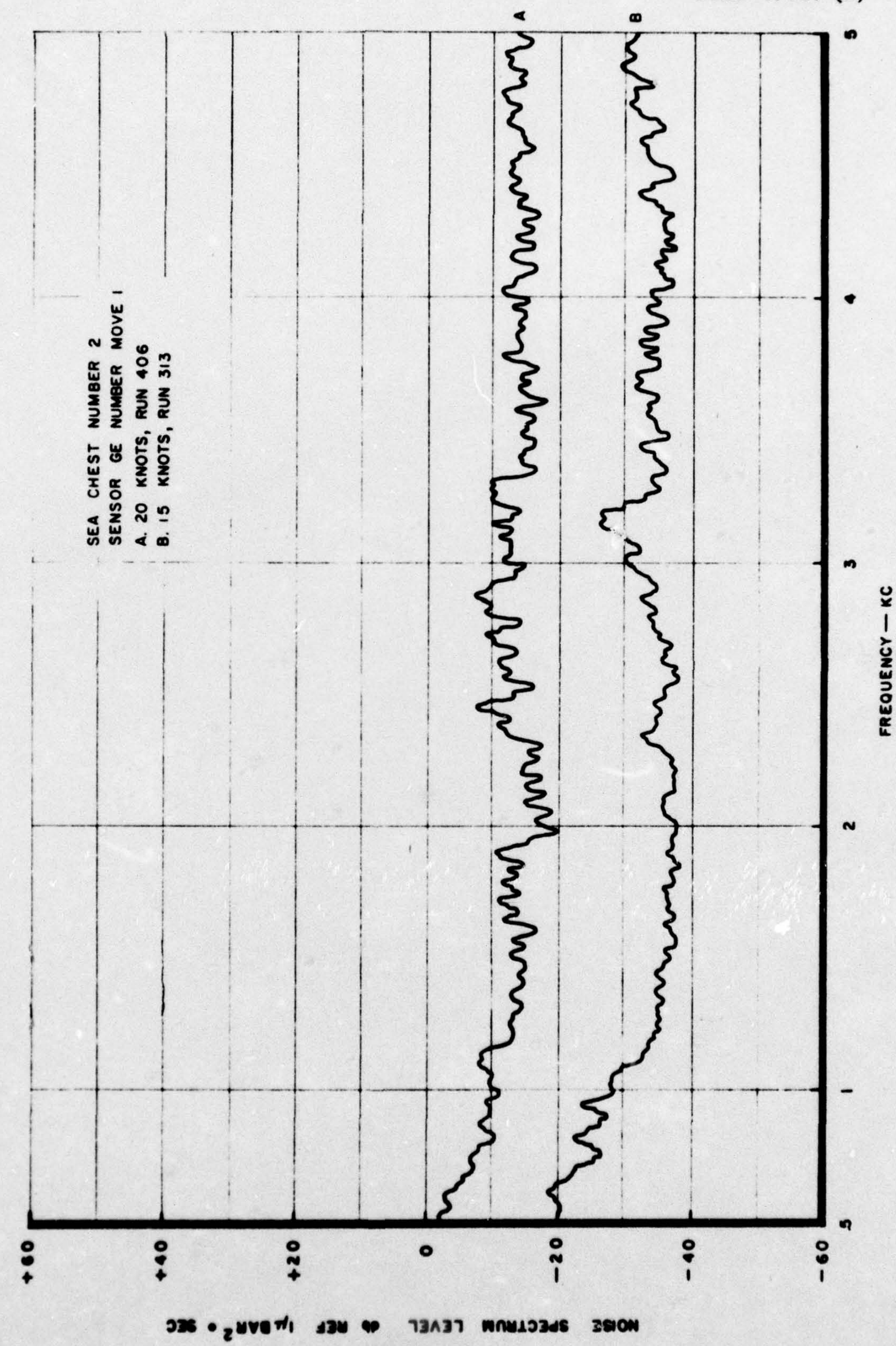


FIGURE 2-55

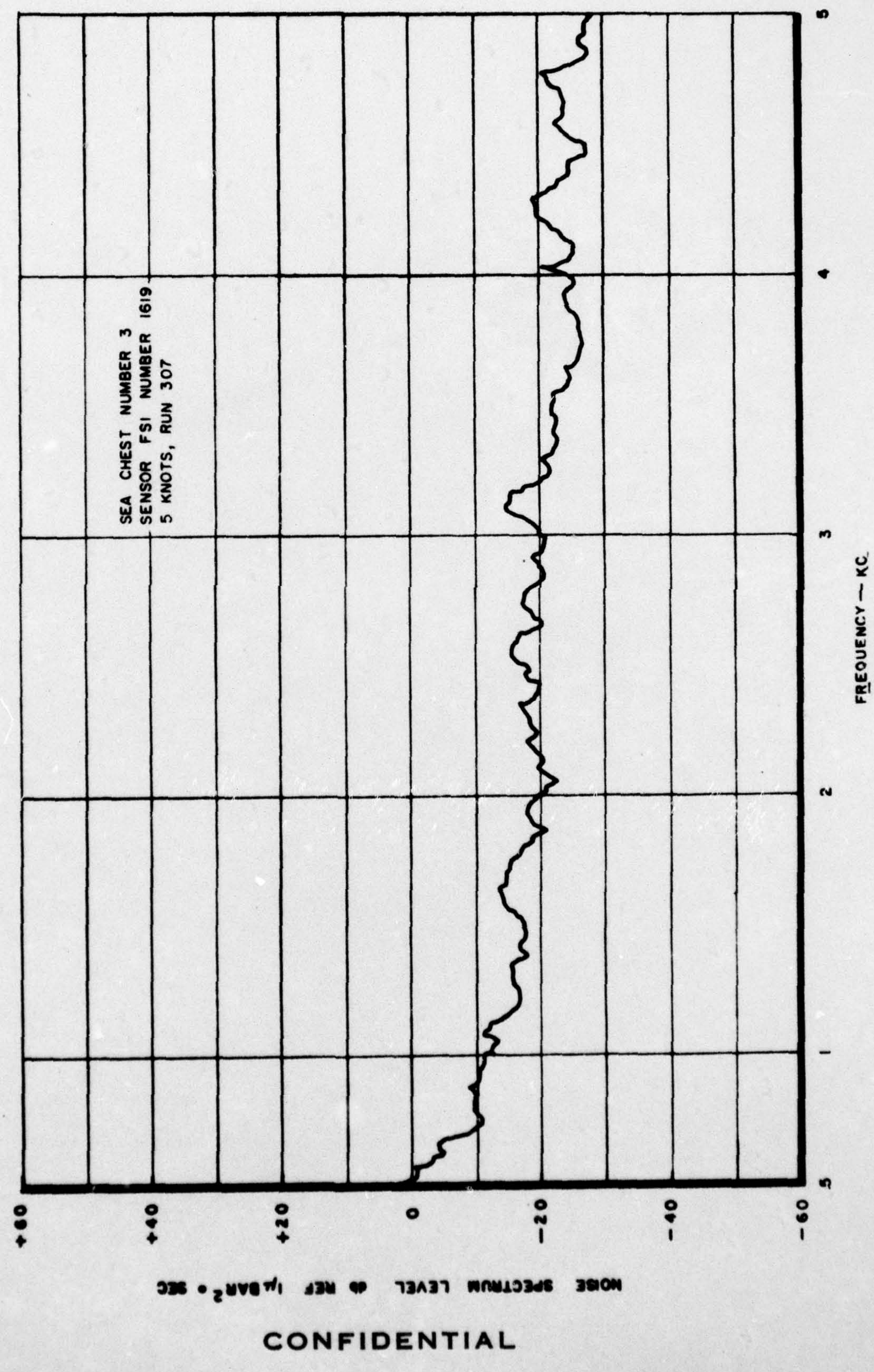

SEA CHEST NUMBER 3
SENSOR FSI NUMBER 1619
5 KNOTS, RUN 307
+60
+40
+20
0
-20
-40
-60
NOISE SPECTRUM LEVEL db REF 1μBAR² • SEC
.5
1
2
3
4
5
FREQUENCY — KC

FIGURE 2-56

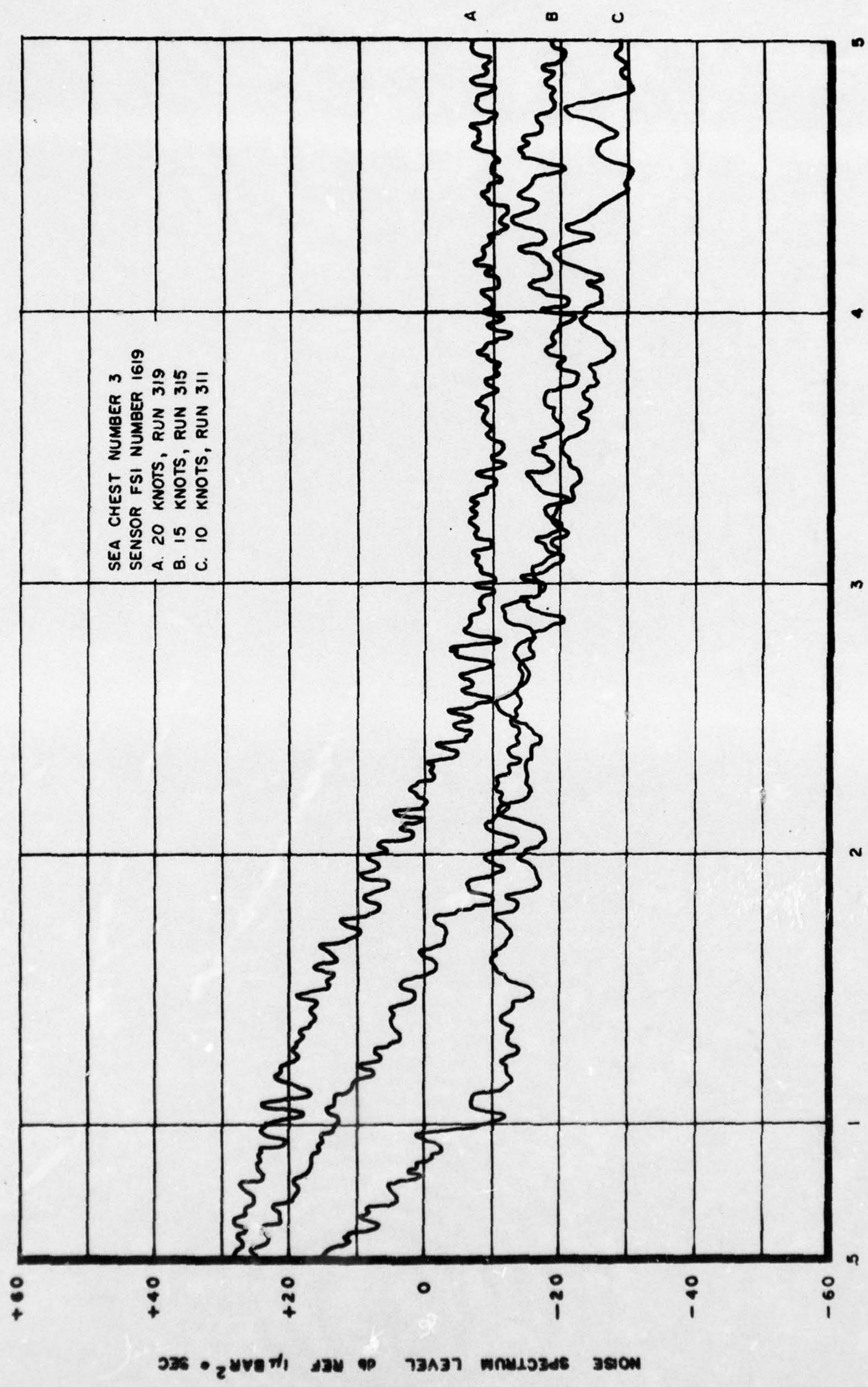

SEA CHEST NUMBER 3
SENSOR FSI NUMBER 1619
A. 20 KNOTS, RUN 319
B. 15 KNOTS, RUN 315
C. 10 KNOTS, RUN 311
A
B
C
+60
+40
+20
0
-20
-40
-60
.5
1
2
3
4
5
NOISE SPECTRUM LEVEL db REF 1μBAR²• SEC
FREQUENCY — KC

FIGURE 2-57

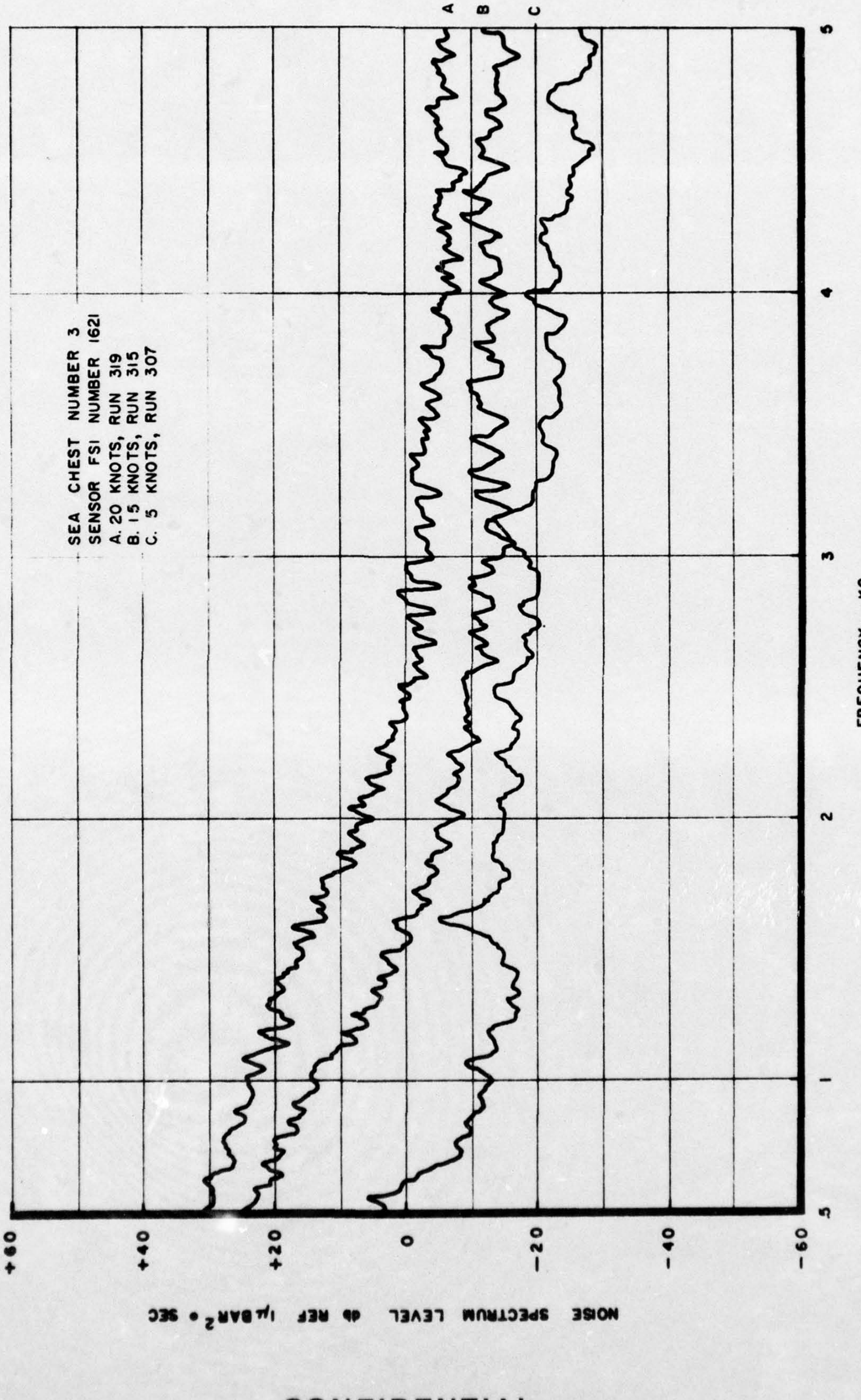

SEA CHEST NUMBER 3
SENSOR FSI NUMBER 1621
A. 20 KNOTS, RUN 319
B. 15 KNOTS, RUN 315
C. 5 KNOTS, RUN 307
A
B
C
+60
+40
+20
0
-20
-40
-60
.5
1
2
3
4
5
FREQUENCY — KC
NOISE SPECTRUM LEVEL db REF 1μBAR² • SEC

FIGURE 2-58

CONFIDENTIAL

B026-47007(A)

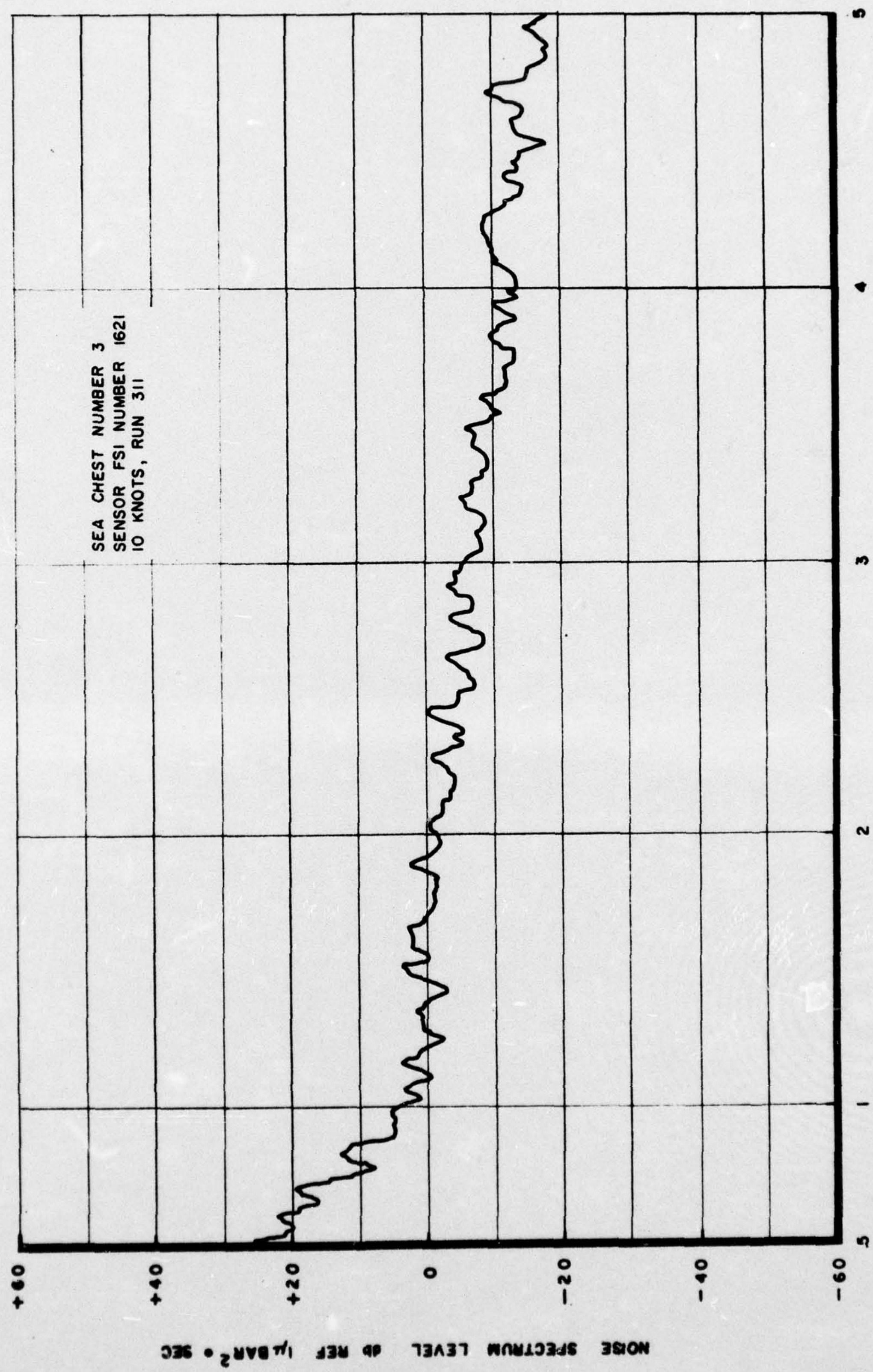


FIGURE 2-59

CONFIDENTIAL

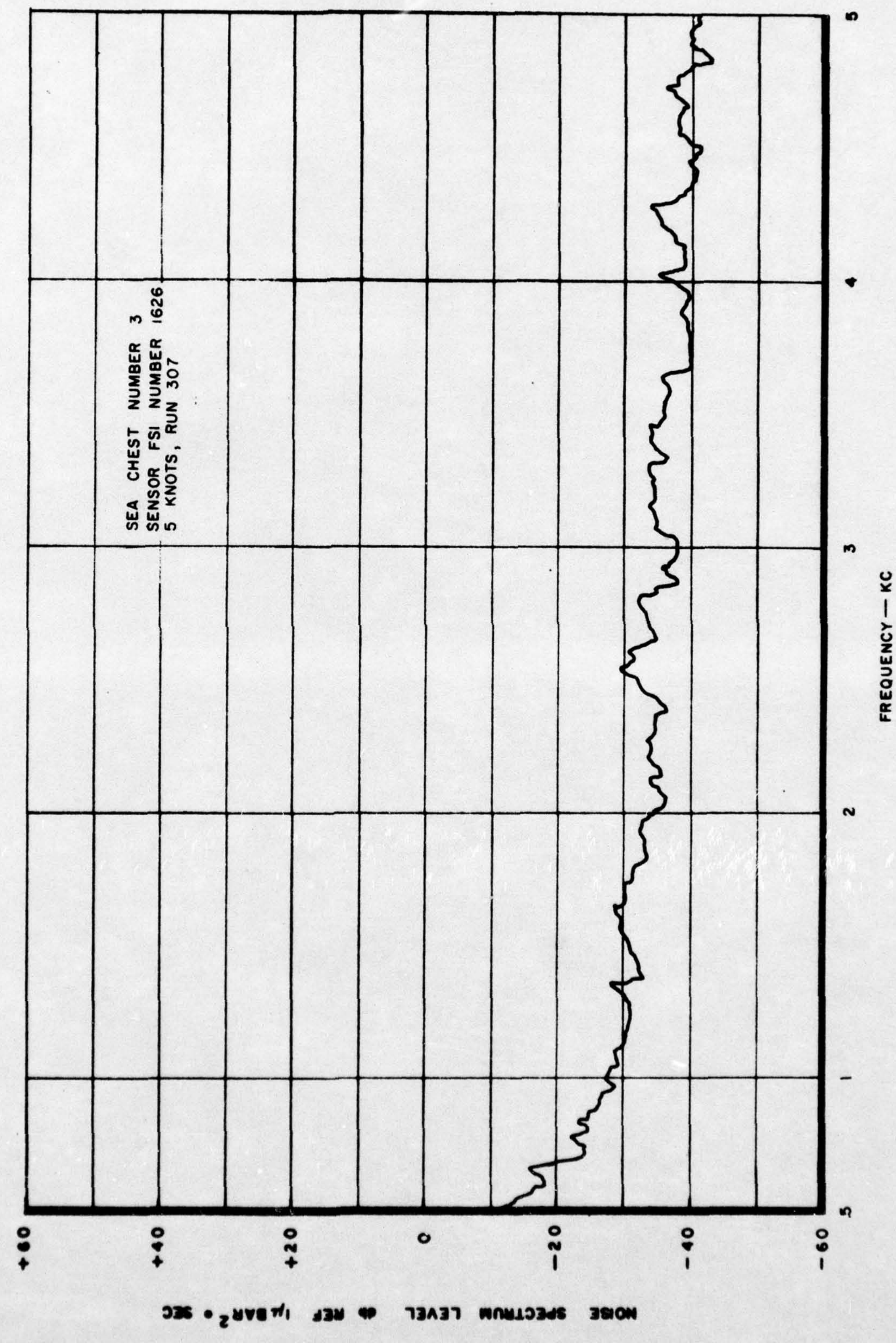

SEA CHEST NUMBER 3
SENSOR FSI NUMBER 1626
5 KNOTS, RUN 307
+60
+40
+20
0
-20
-40
-60
.5
1
2
3
4
5
FREQUENCY — KC
NOISE SPECTRUM LEVEL db REF 1μBAR² • SEC

FIGURE 2-60

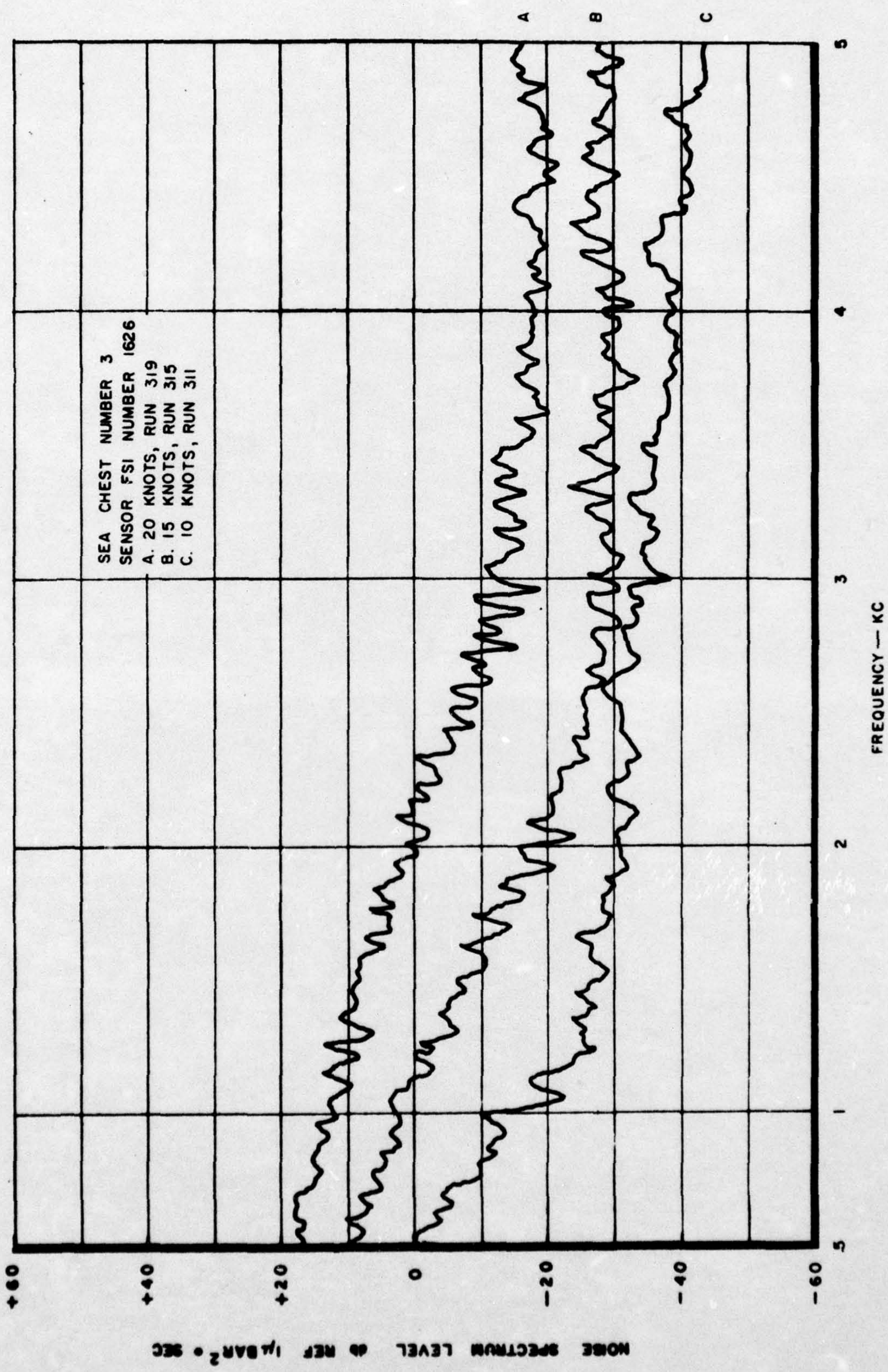

SEA CHEST NUMBER 3
SENSOR FSI NUMBER 1626
A. 20 KNOTS, RUN 319
B. 15 KNOTS, RUN 315
C. 10 KNOTS, RUN 311
A
B
C
+60
+40
+20
0
-20
-40
-60
NOISE SPECTRUM LEVEL db REF 1μBAR² • SEC
.5
1
2
3
4
5
FREQUENCY — KC

FIGURE 2-61

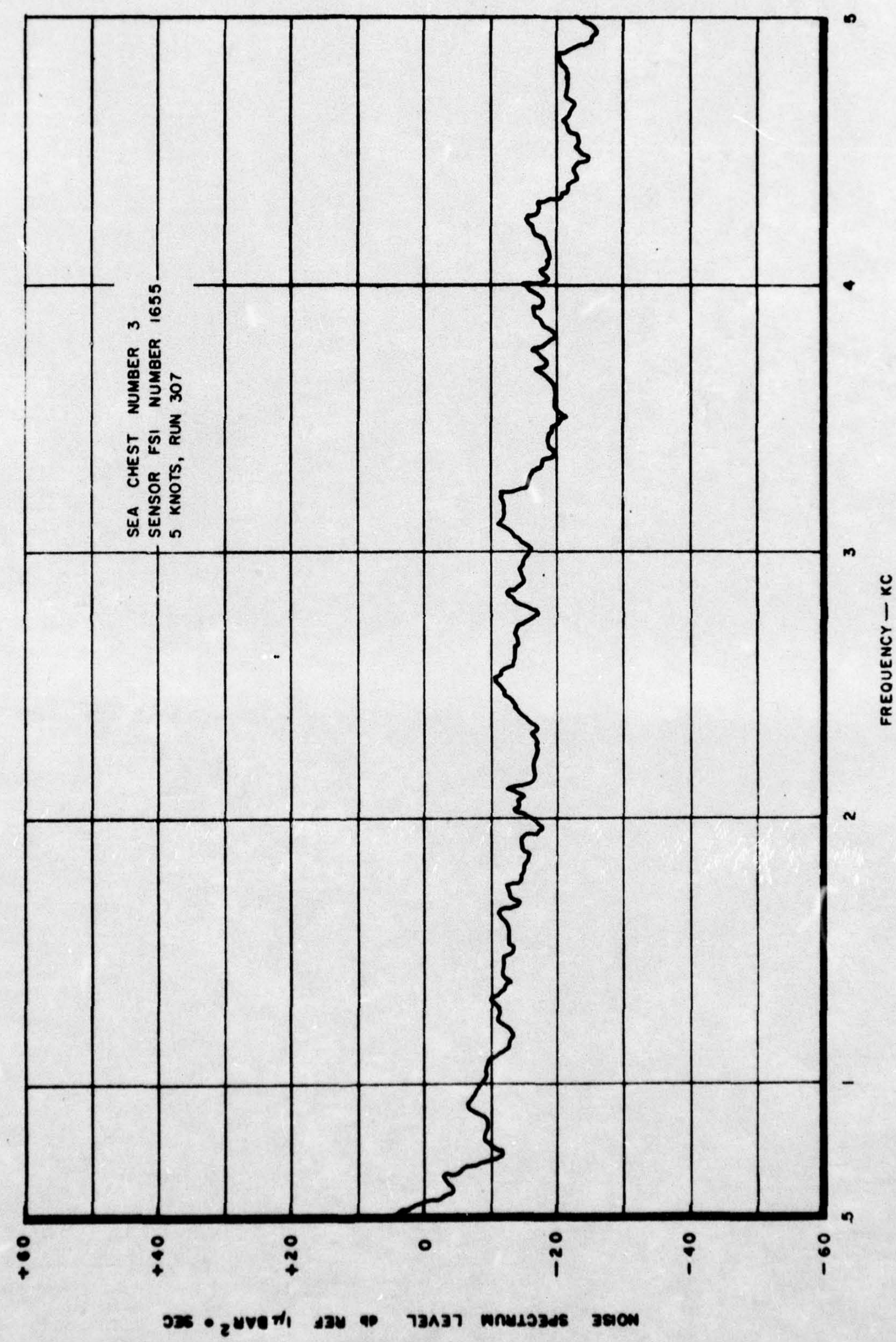
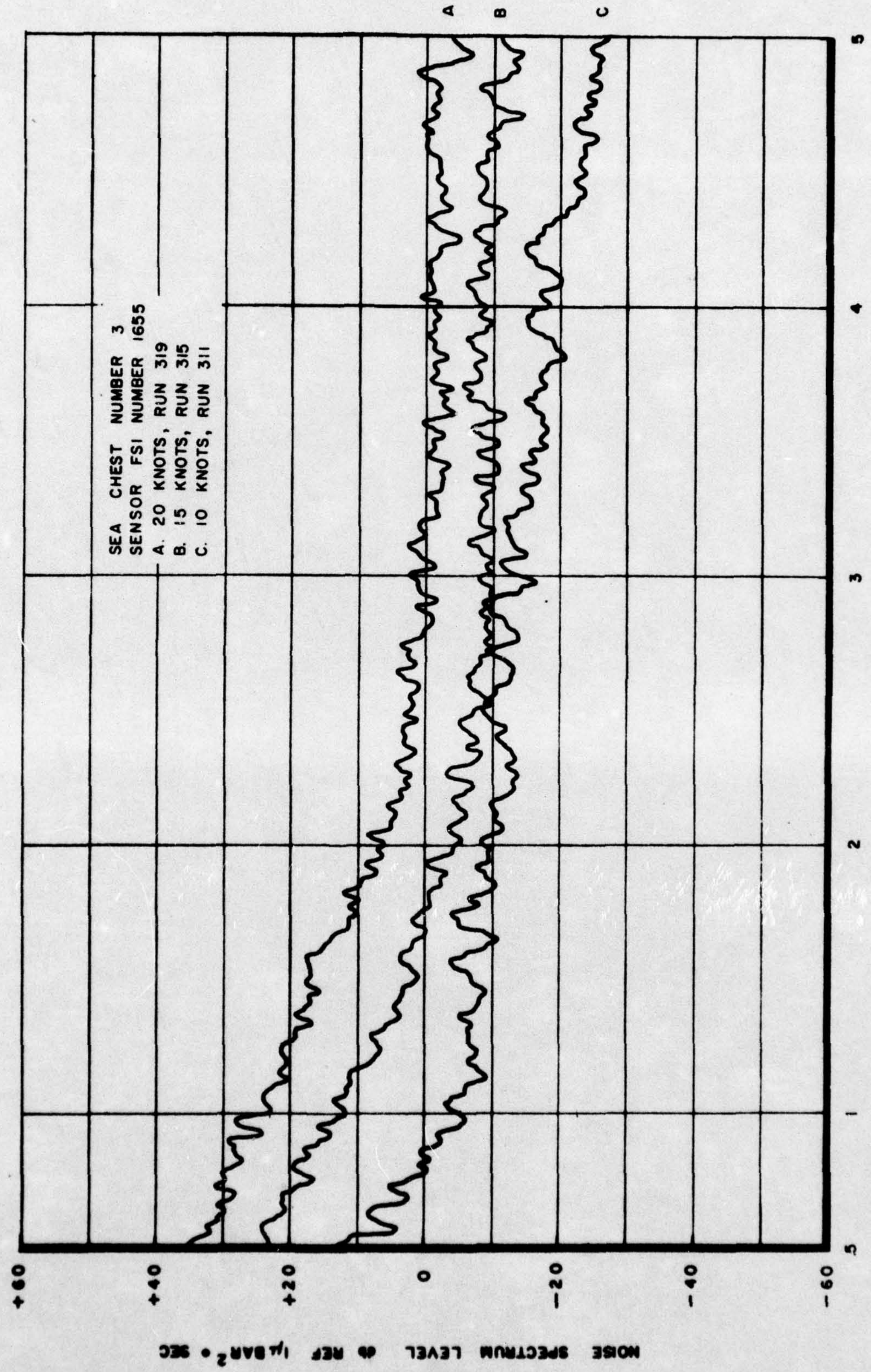

SEA CHEST NUMBER 3
SENSOR FSI NUMBER 1655
5 KNOTS, RUN 307
+60
+40
+20
0
-20
-40
-60
NOISE SPECTRUM LEVEL db REF 1μBAR² • SEC
1
2
3
4
5
FREQUENCY — KC

FIGURE 2-62



FREQUENCY — KC
FIGURE 2-63

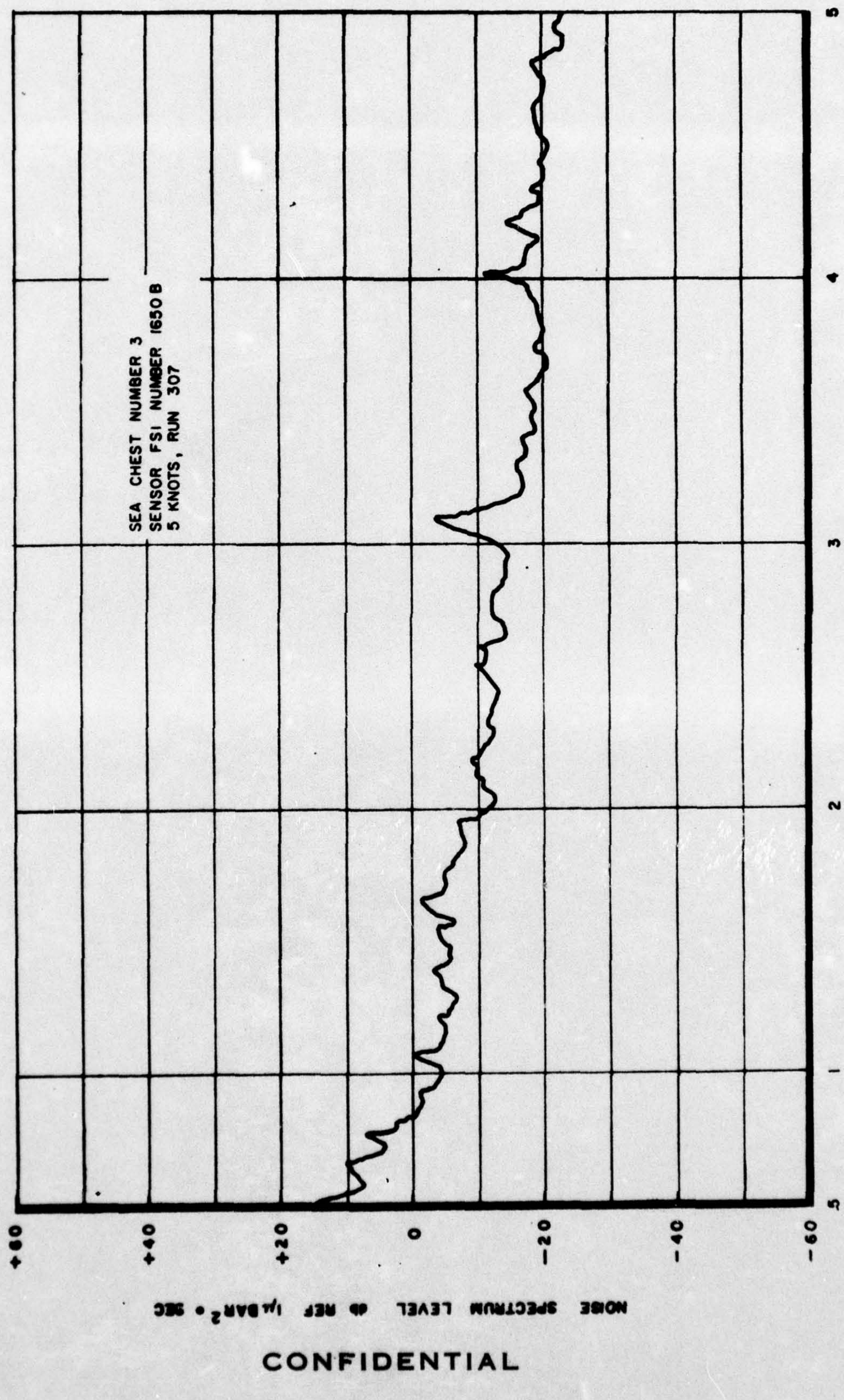

SEA CHEST NUMBER 3
SENSOR FSI NUMBER 1650 B
5 KNOTS, RUN 307
+60
+40
+20
0
-20
-40
-60
.5
1
2
3
4
5
NOISE SPECTRUM LEVEL db REF 1 μBAR² • SEC
FRFQUENCY — KC

FIGURE 2-64

CONFIDENTIAL

B026-47007 (A)

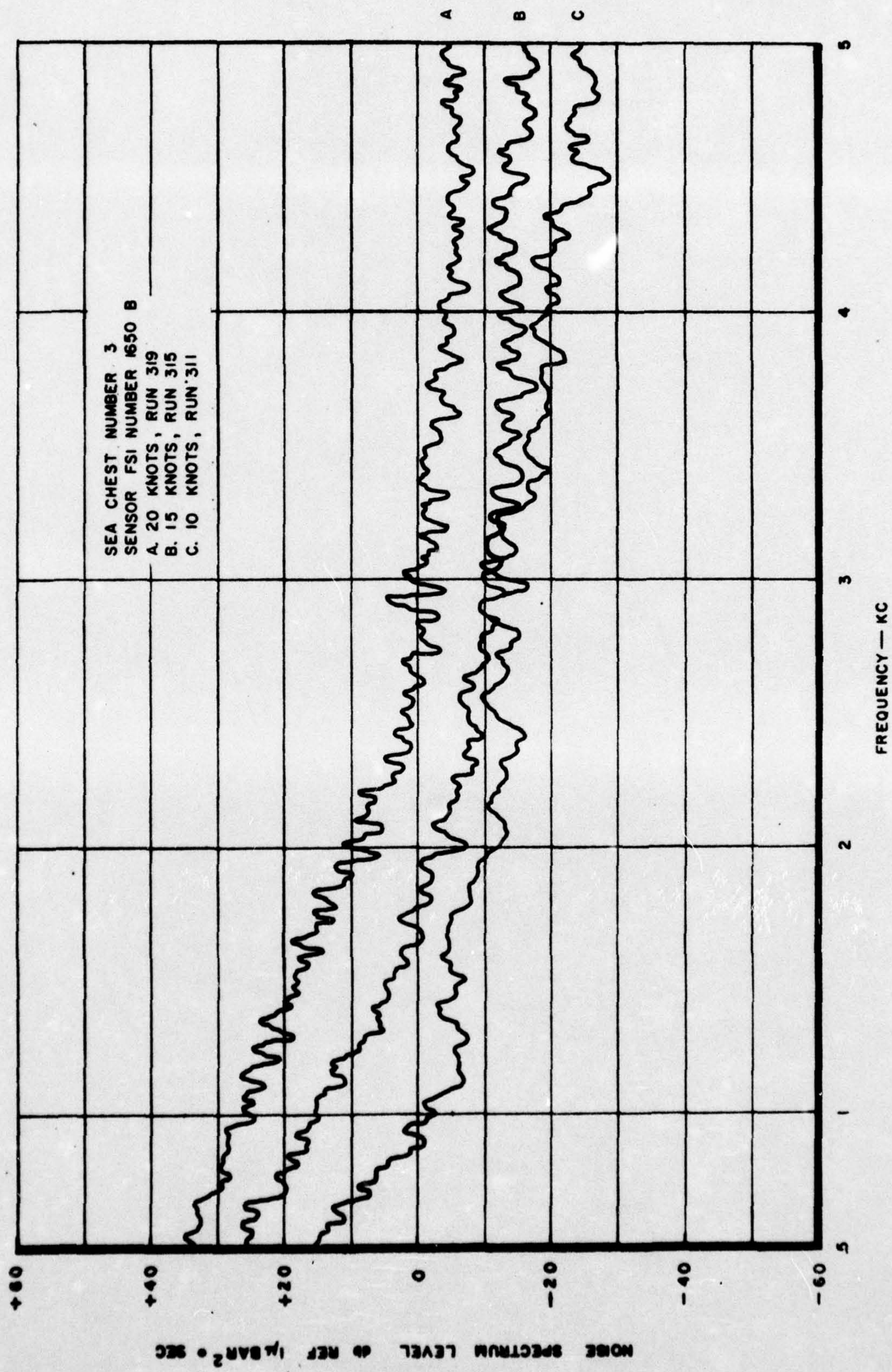


FIGURE 2-65

CONFIDENTIAL

B026-47007(A)

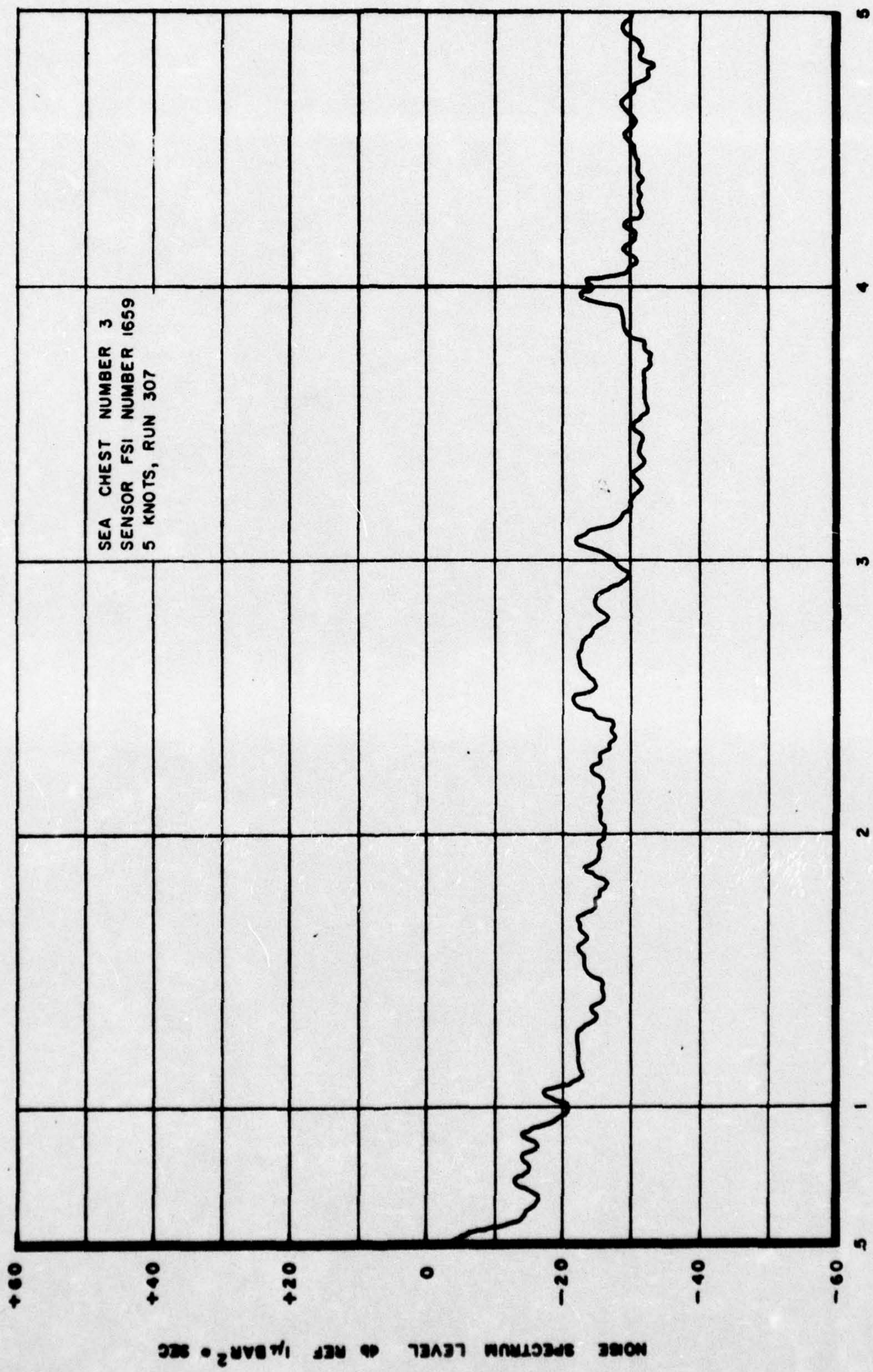


FIGURE 2-66

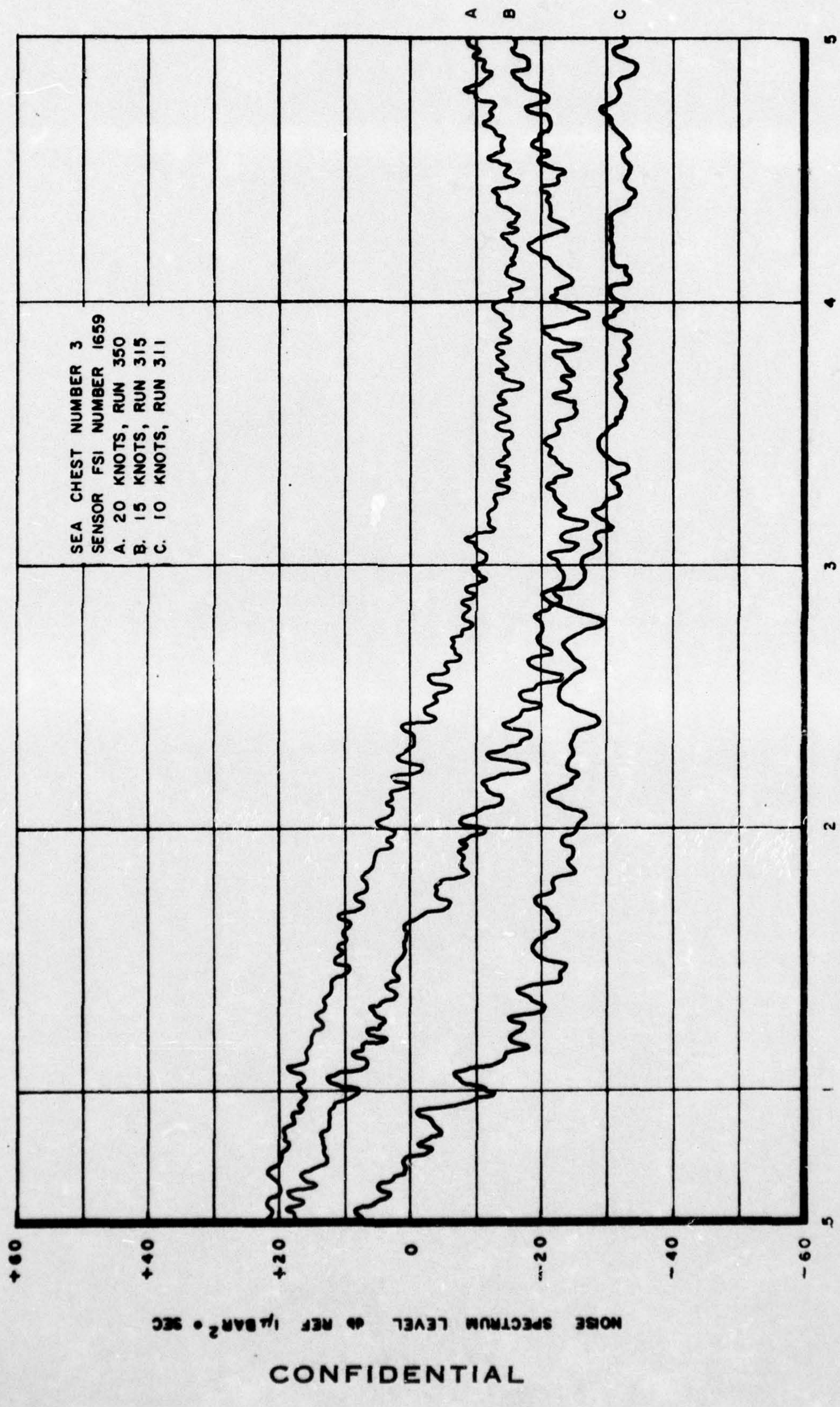

SEA CHEST NUMBER 3
SENSOR FSI NUMBER 1659
A. 20 KNOTS, RUN 350
B. 15 KNOTS, RUN 315
C. 10 KNOTS, RUN 311
A
B
C
+60
+40
+20
0
-20
-40
-60
NOISE SPECTRUM LEVEL db REF 1μBAR² • SEC
.5
1
2
3
4
5
FREQUENCY — KC

FIGURE 2-67

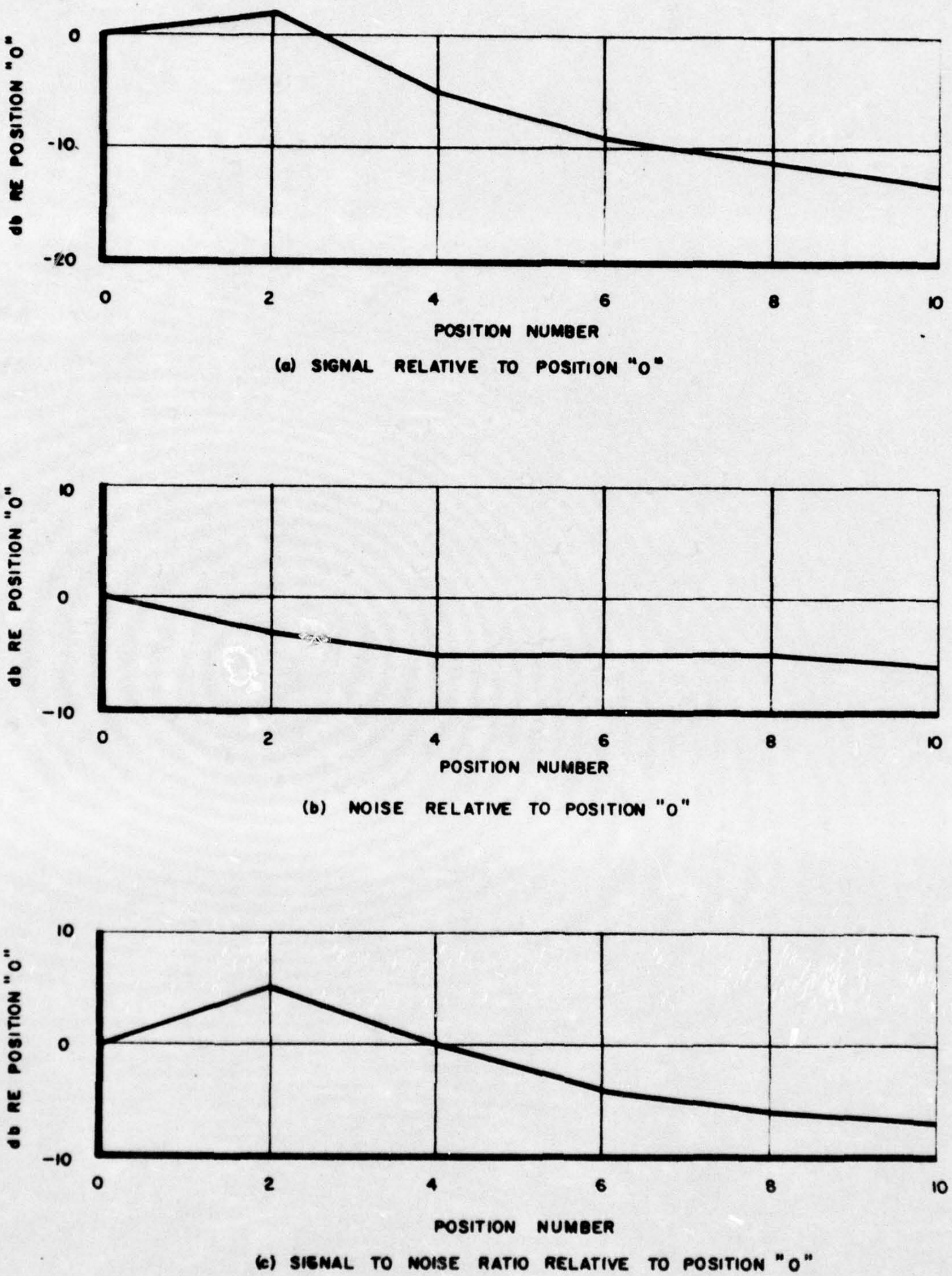
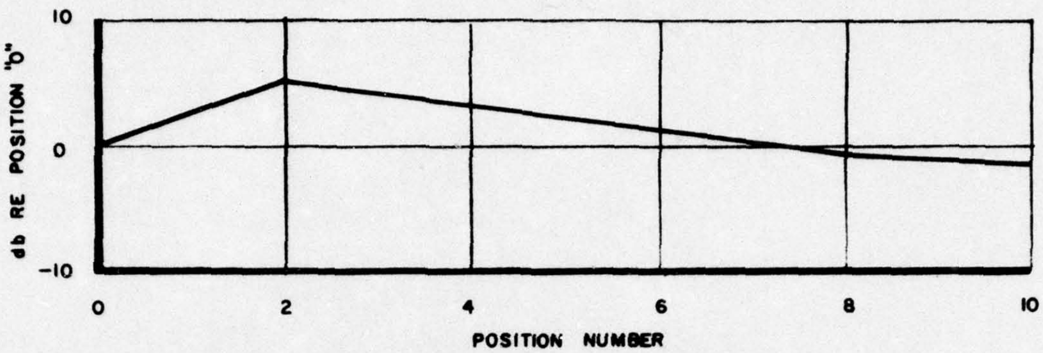
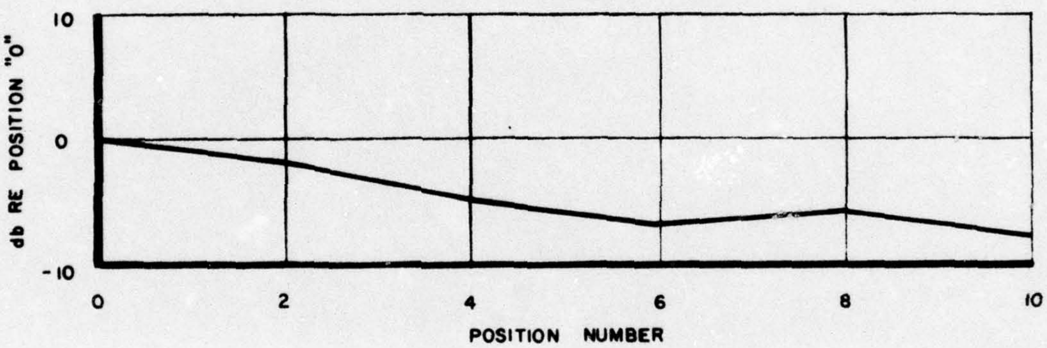


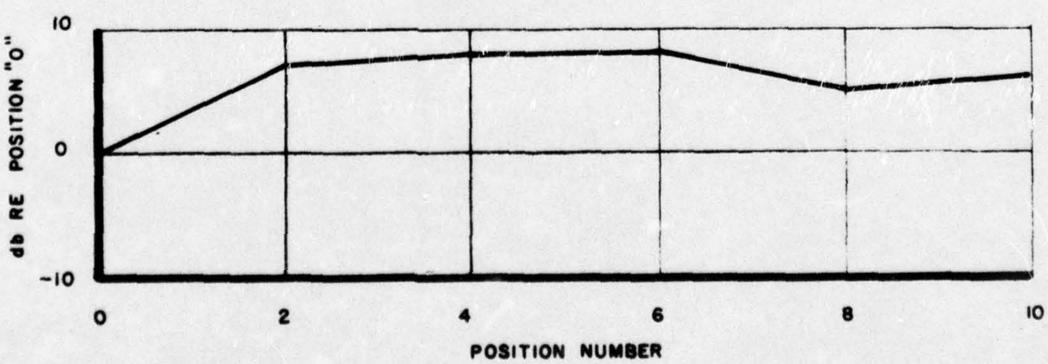
FIGURE 2-68. GE BAR EXPERIMENT, TRANSDUCER, MOVE 1, F=1 KC



(a) SIGNAL RELATIVE TO POSITION "O"

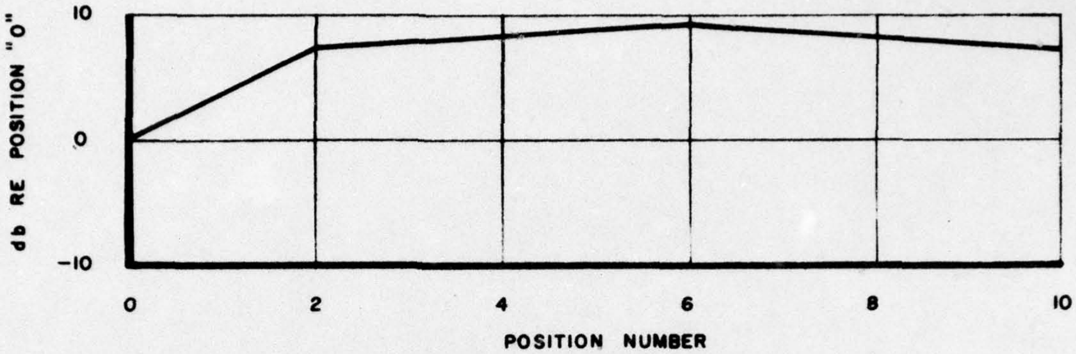


(b) NOISE RELATIVE TO POSITION "O"

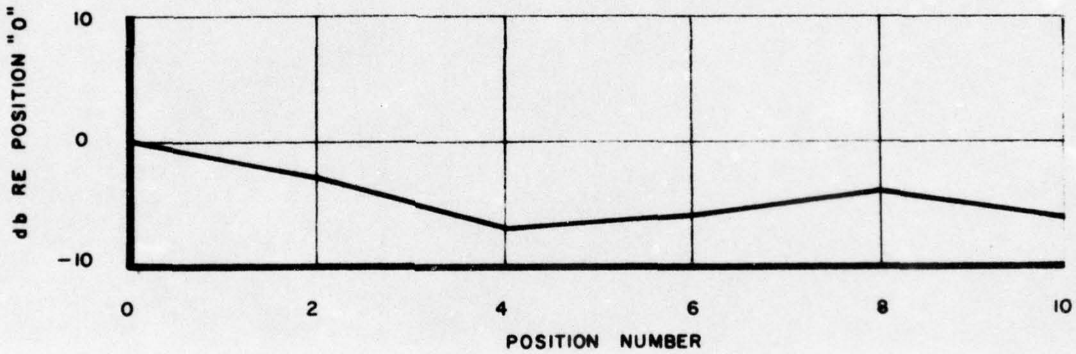


(c) SIGNAL TO NOISE RATIO RELATIVE TO POSITION "O"

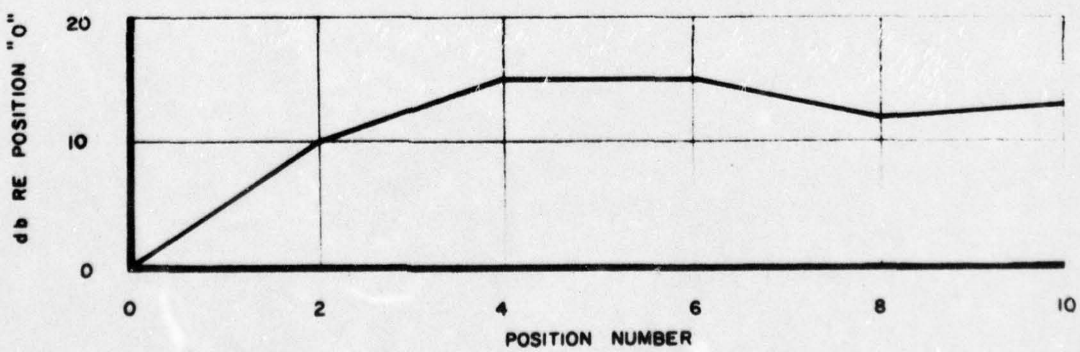
FIGURE 2-69. GE BAR EXPERIMENT, TRANSDUCER, MOVE 1, F=2 KC



(a) SIGNAL RELATIVE TO POSITION "O"



(b) NOISE RELATIVE TO POSITION "O"

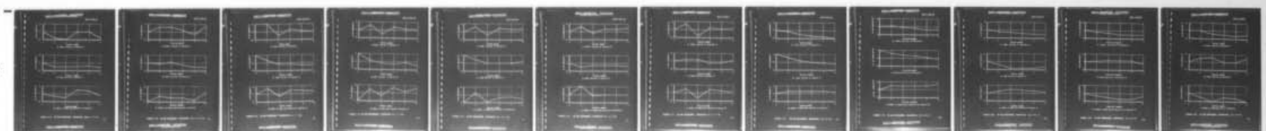


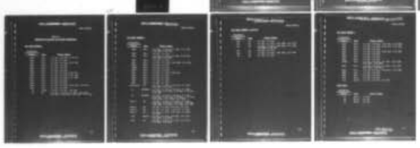
(c) SIGNAL TO NOISE RATIO RELATIVE TO POSITION "O"

FIGURE 2-70. GE BAR EXPERIMENT, TRANSDUCER, MOVE 1, F=3 KC

AD-A031 793 CONTROL DATA CORP MELVILLE N Y TRG DIV F/G 17/1
PURVIS I ACOUSTIC TESTS,(U)
JUN 66 S GARDNER NOBSR-93023
UNCLASSIFIED TRG-023-TM-66-19 NL

2 OF 2
AD
A031793





END
DATE
FILMED
12-76

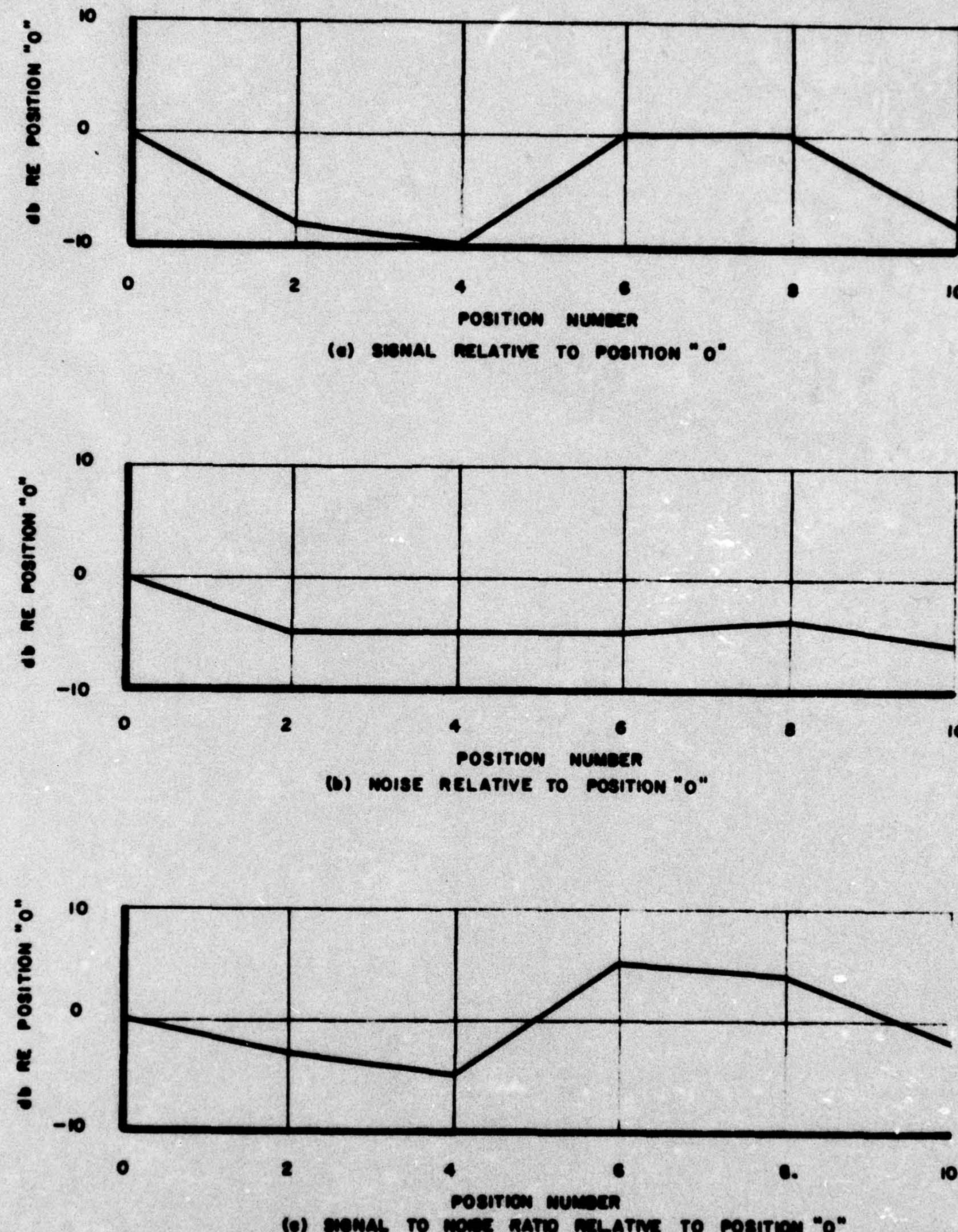
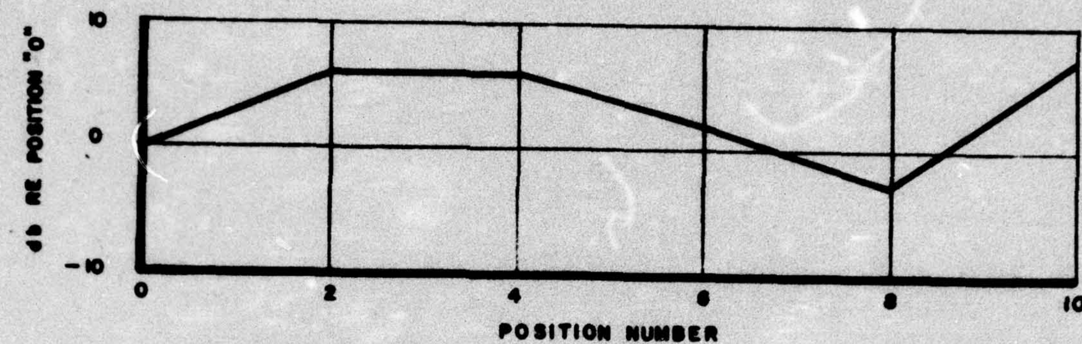
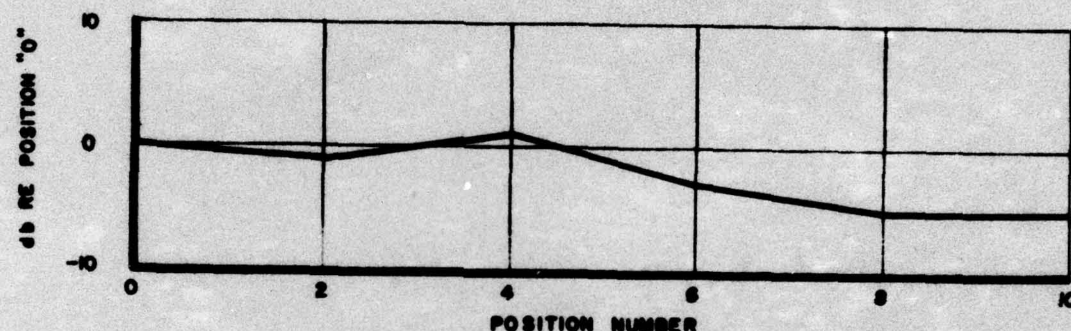


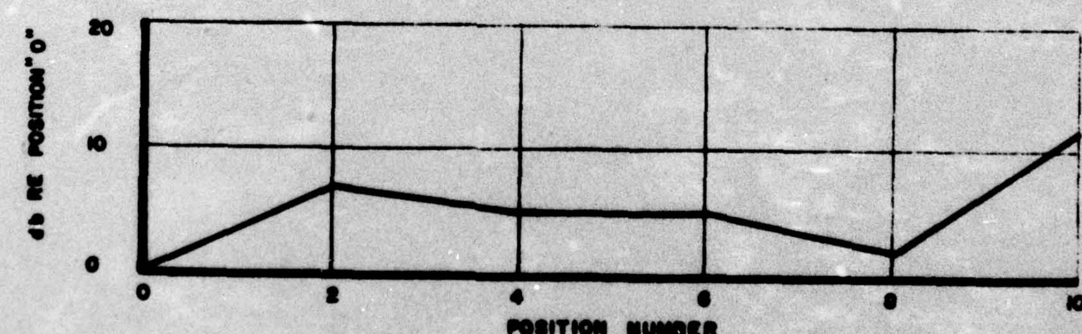
FIGURE 2-71. GE BAR EXPERIMENT, TRANSDUCER, MOVE 1, F=4 KC



(a) SIGNAL RELATIVE TO POSITION "O"

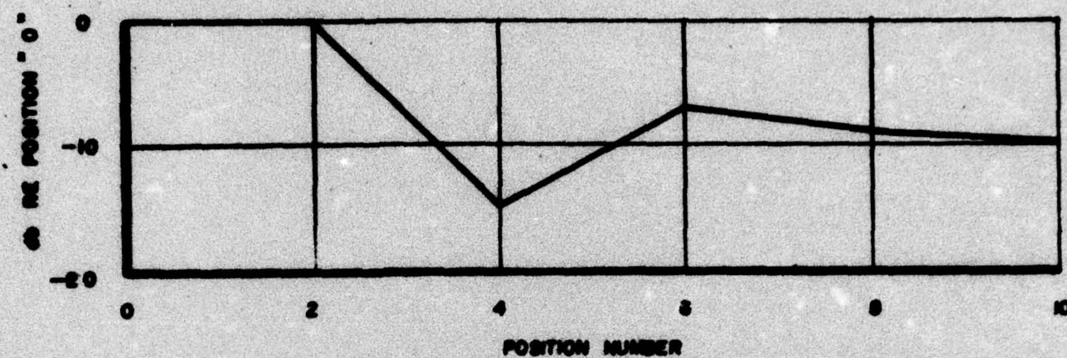


(b) NOISE RELATIVE TO POSITION "O"

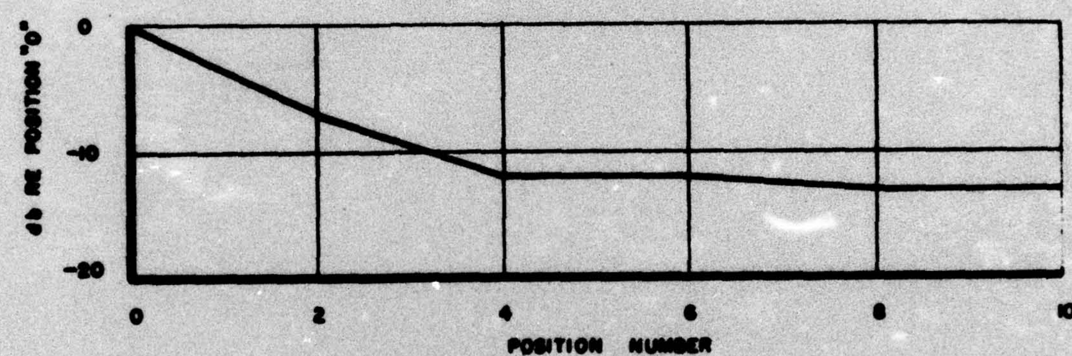


(c) SIGNAL TO NOISE RATIO RELATIVE TO POSITION

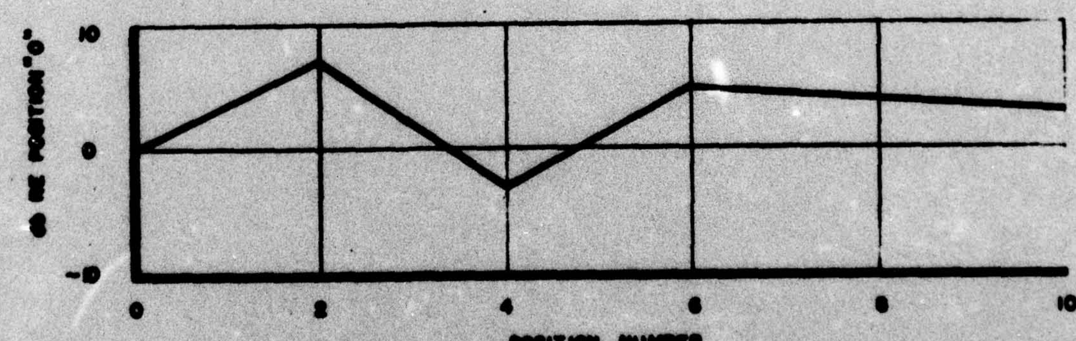
FIGURE 2-72. GE BAR EXPERIMENT, TRANSDUCER, Move 1, F=5 KC



(a) SIGNAL RELATIVE TO POSITION "0"



(b) NOISE RELATIVE TO POSITION "0"



(b) SIGNAL TO NOISE RATIO RELATIVE TO POSITION "0"

FIGURE 2-73. GE BAR EXPERIMENT' TRANSDUCER 1L1, f = 1kc.

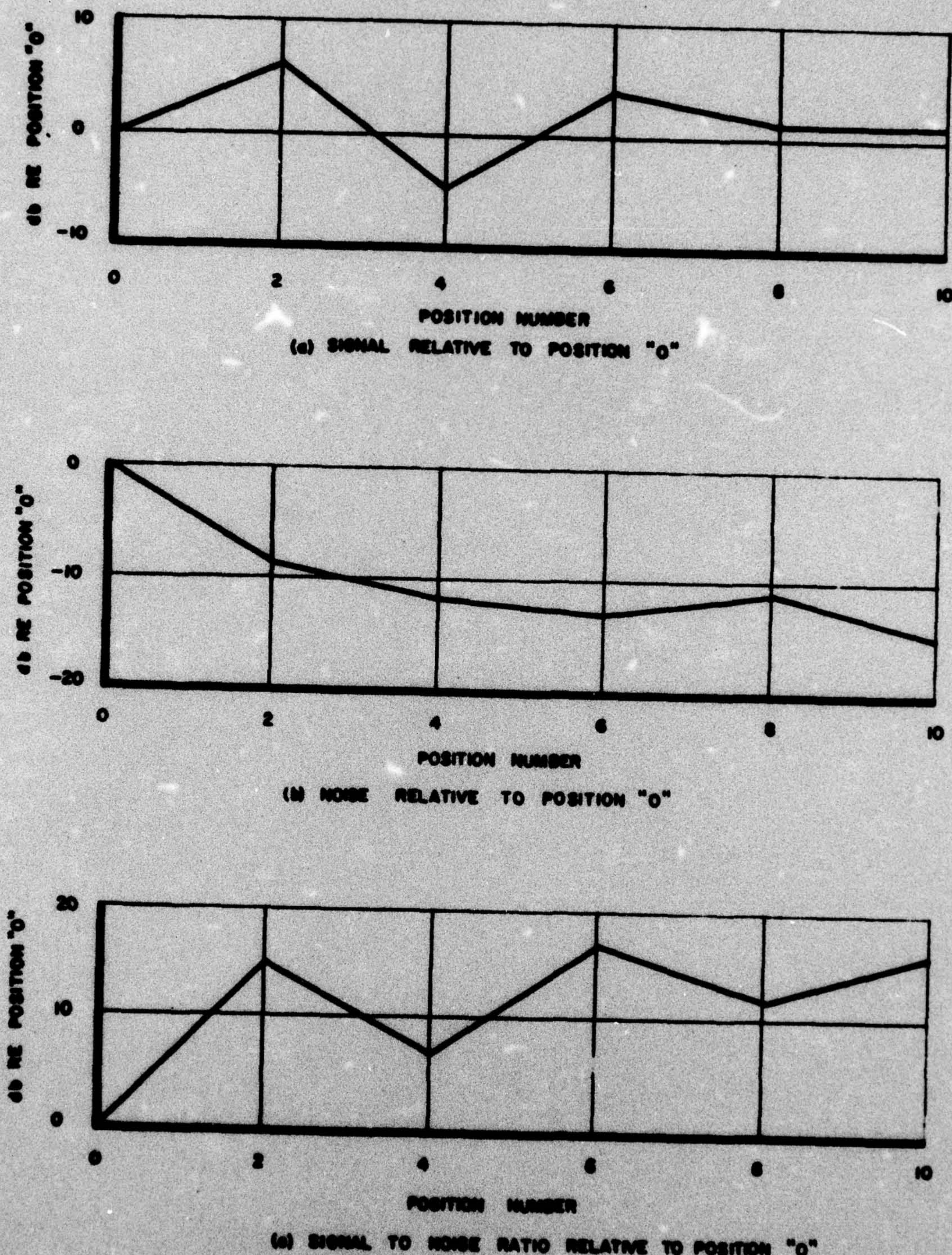
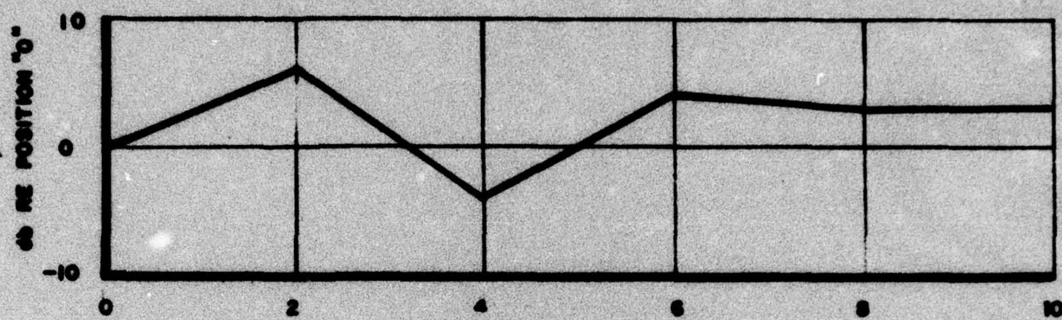
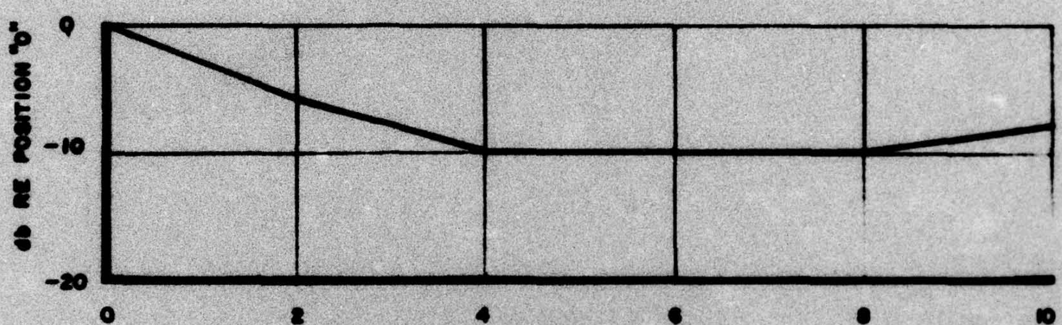


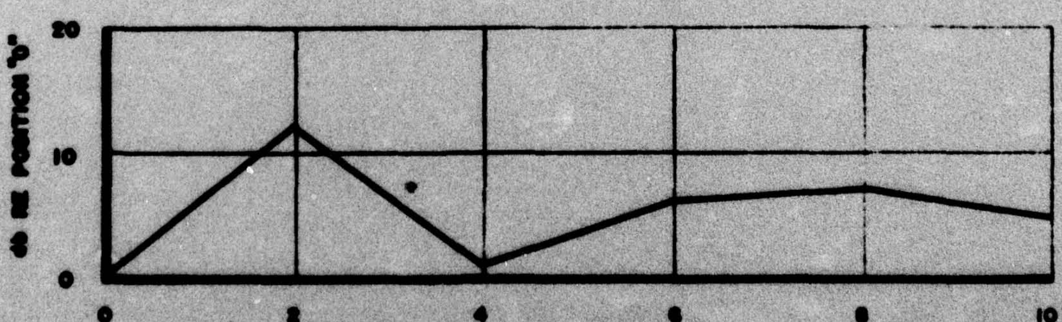
FIGURE 2-74. GE BAR EXPERIMENT, TRANSDUCER 1L1, f = 2kc.



(a) SIGNAL RELATIVE TO POSITION "0"



(b) NOISE RELATIVE TO POSITION "0"



(c) SIGNAL TO NOISE RATIO RELATIVE TO POSITION "0"

FIGURE 2-75. GE BAR EXPERIMENT, TRANSDUCER 111, F = 3 KC

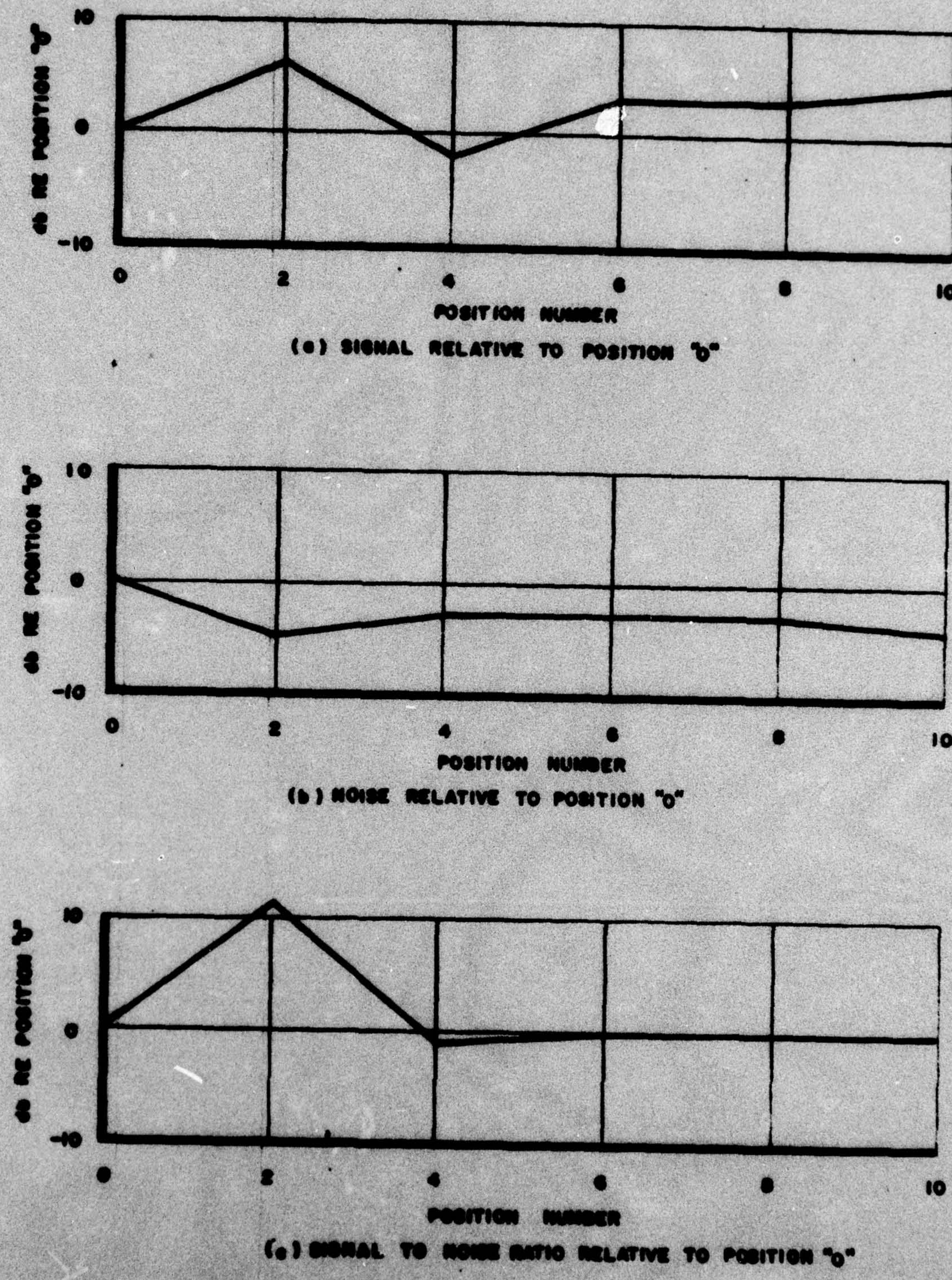


FIGURE 2-76. GE BAR EXPERIMENT, TRANSDUCER 1L1, F = 4 KC

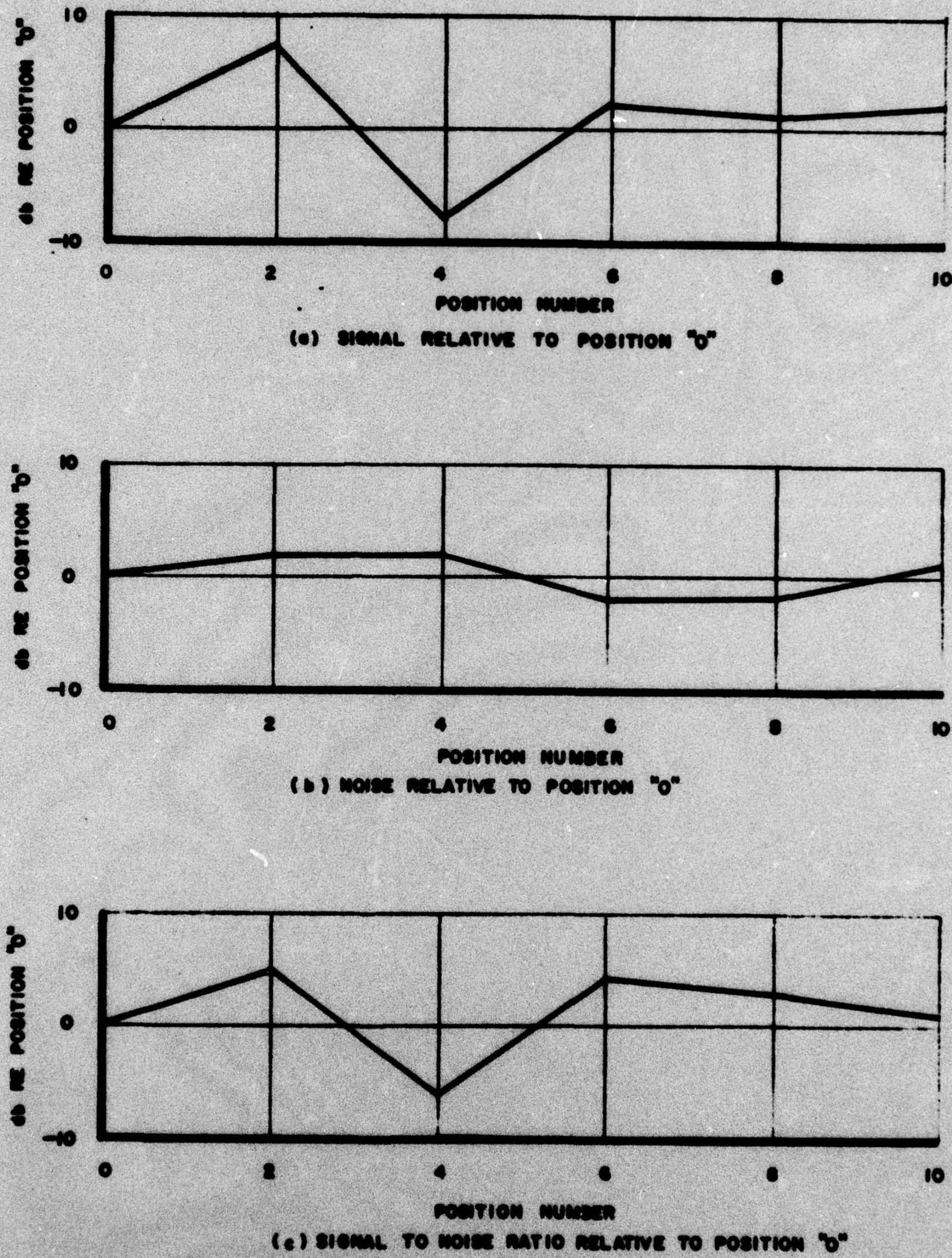


FIGURE 2-77. GE BAR EXPERIMENT, TRANSDUCER 1L1, F = 5 KC

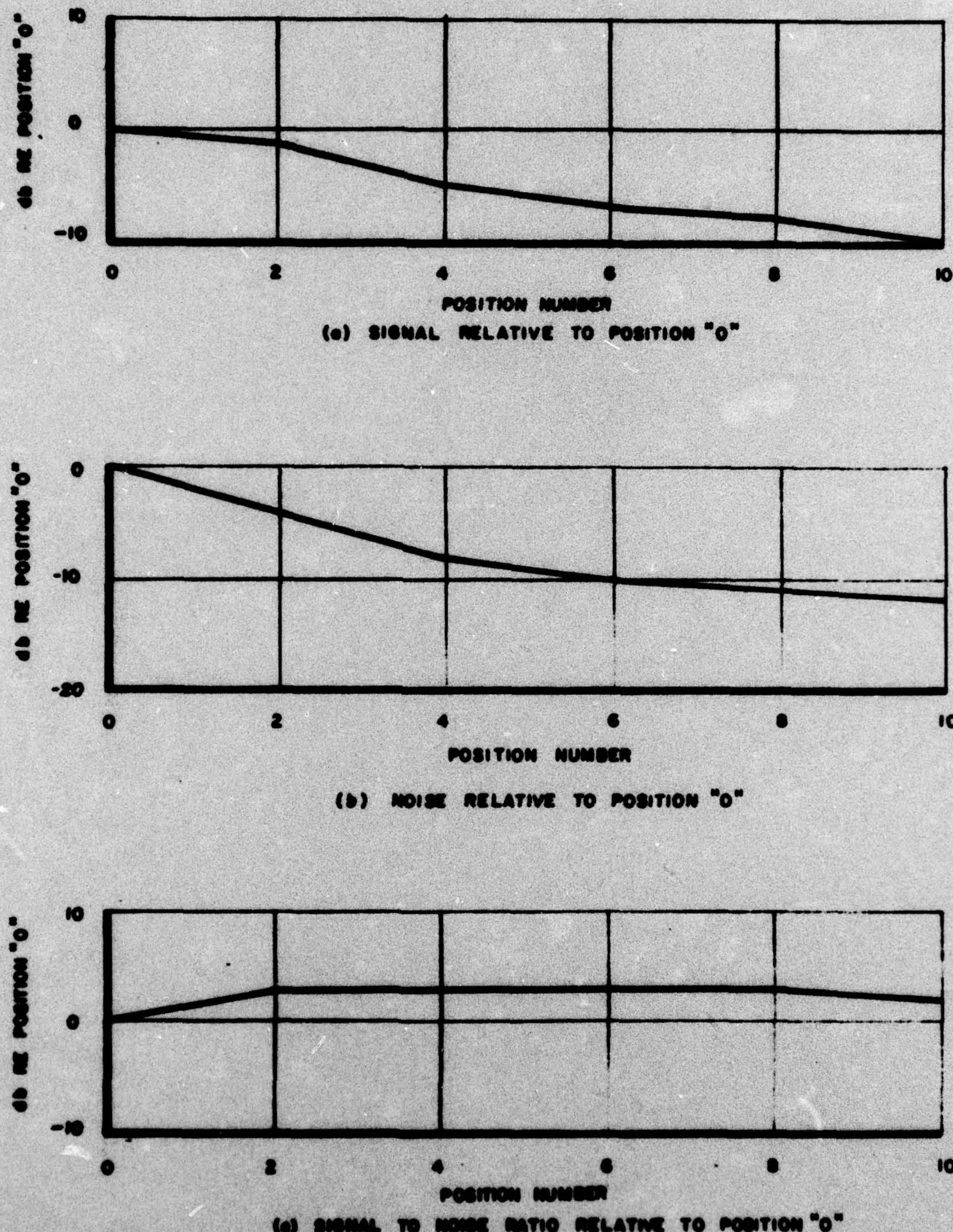
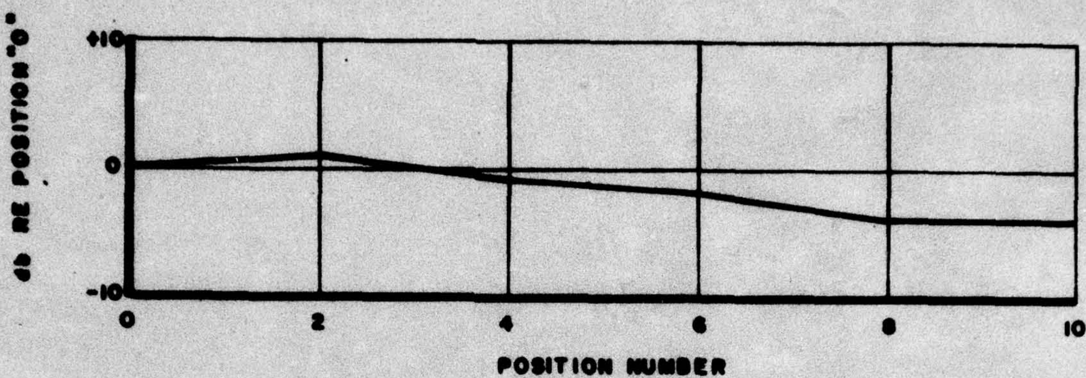
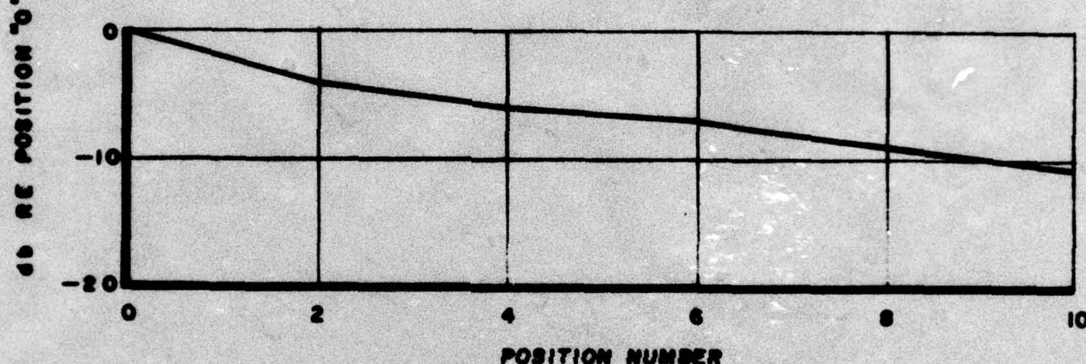


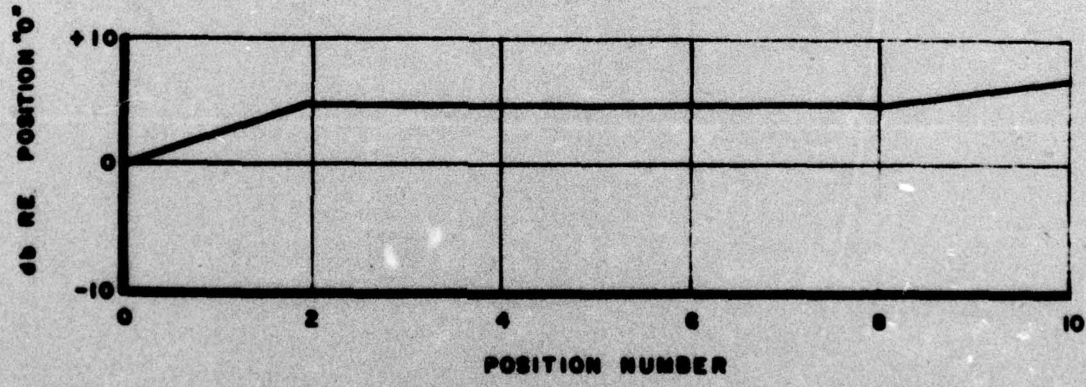
FIGURE 2-78. GE BAR EXPERIMENT, TRANSDUCER, 1L2, F=1 KC



(a) SIGNAL RELATIVE TO POSITION "O"



(b) NOISE RELATIVE TO POSITION "O"



(c) SIGNAL TO NOISE RATIO RELATIVE TO POSITION "O"

FIGURE 2-79. GE BAR EXPERIMENT, TRANSDUCER, 1L2, F=2 KC

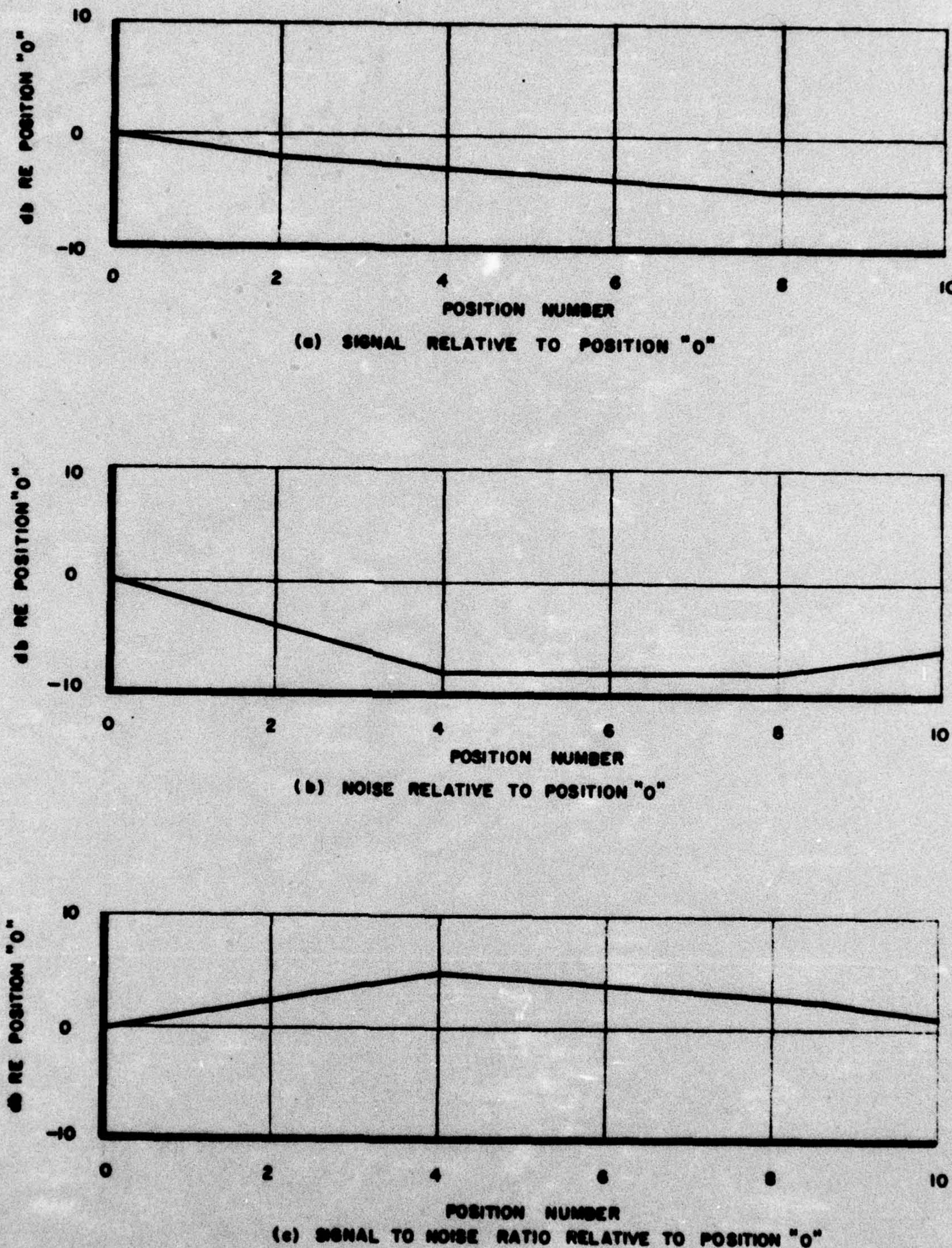


FIGURE 2-80. GE BAR EXPERIMENT, TRANSDUCER, 1L2, F=3, KC

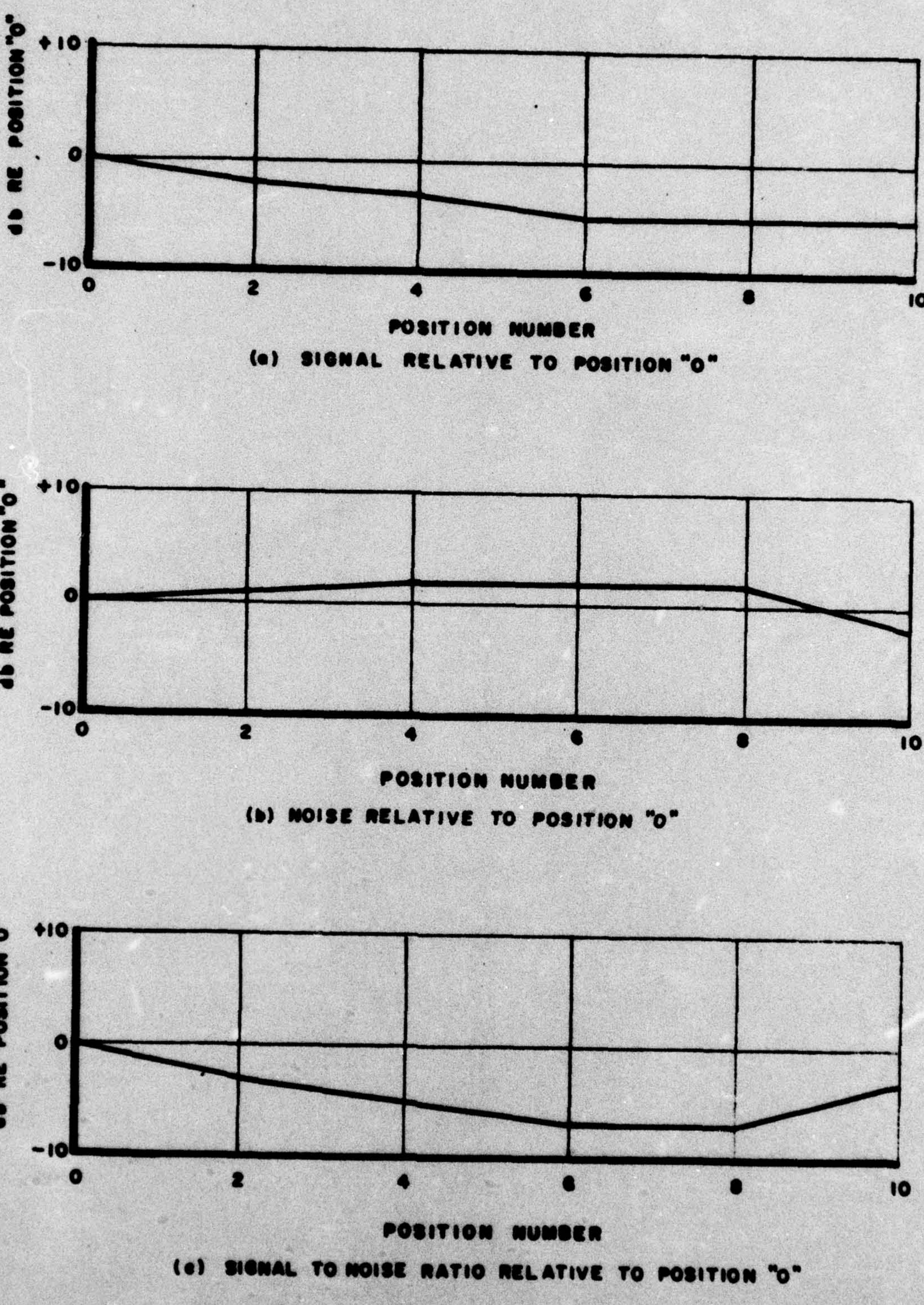


FIGURE 2-81. GE BAR EXPERIMENT, TRANSUDCER, 1L2, F-4 KC

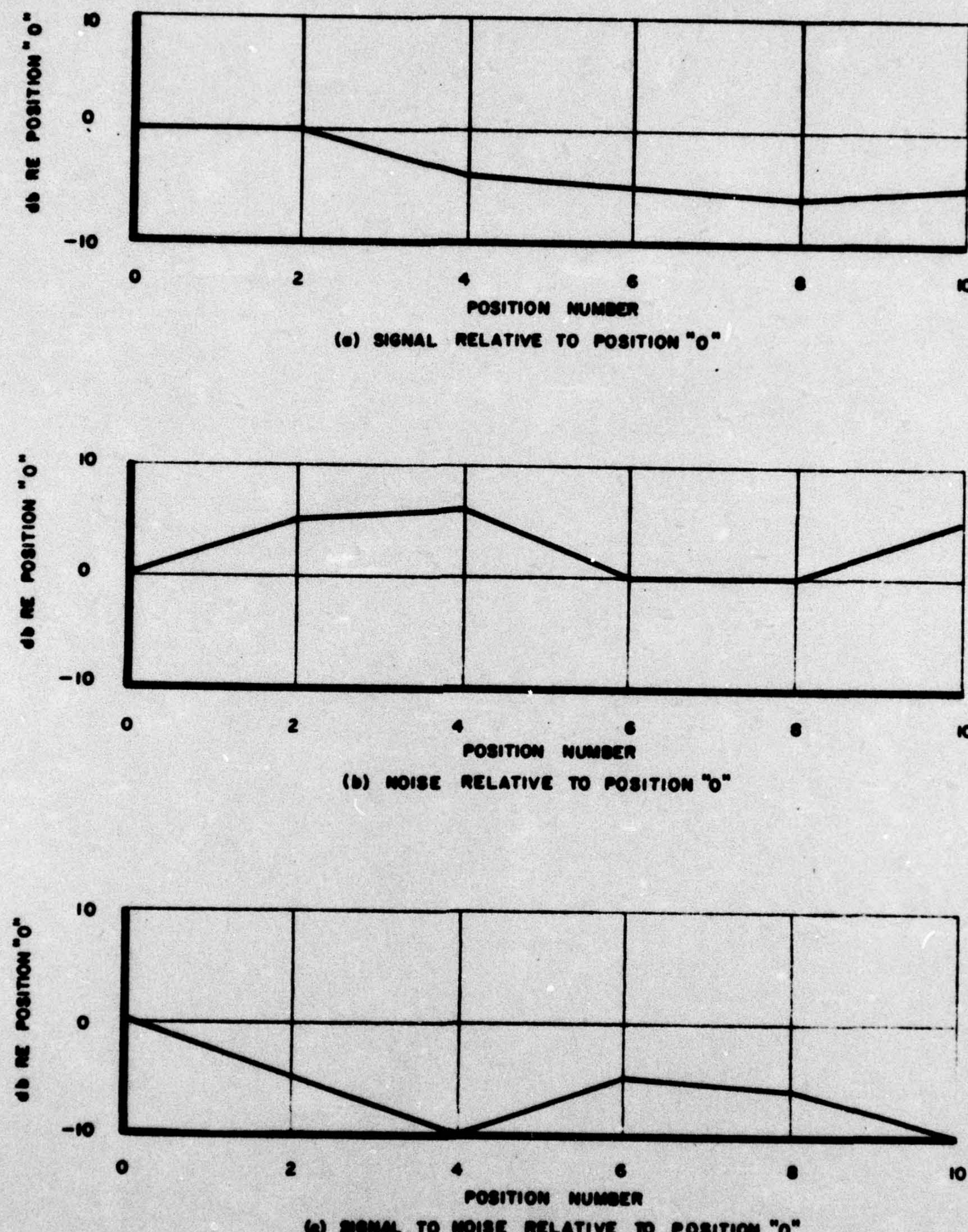


FIGURE 2-82. GE BAR EXPERIMENT, TRANSDUCER, 1L2, F=5 KC

INDEX OF
TRANSDUCER LOCATIONS AND FIGURE REFERENCES

SEA CHEST NUMBER 1

Transducer Identification Number	Type	Figure (Page)
1618	FS-1	1-5 (9), 1-6 (10), 2-23 (45)
1625	FS-1	1-5 (9), 1-6 (10)
1627	FS-1	1-5 (9), 1-6 (10), 2-24 (46)
1629	FS-1	1-5 (9), 1-6 (10)
1636	FS-1	1-5 (9), 1-6 (10)
1637	FS-1	1-5 (9), 1-6 (10)
1638	FS-1	1-5 (9), 1-6 (10), 2-25 (47)
1640	FS-1	1-5 (9), 1-6 (10), 2-26 (48)
1641	FS-1	1-5 (9), 1-6 (10), 2-27 (49)
1643	FS-1	1-5 (9), 1-6 (10)
1656	FS-1	1-5 (9), 1-6 (10)
1666	FS-1	1-5 (9), 1-6 (10), 2-28 (50), 2-29 (51)
1669	FS-1	1-5 (9), 1-6 (10)
33	AX-58	1-5 (9), 1-6 (10), 2-8 (30)
61	GE	1-5 (9), 1-6 (10), 2-6 (28), 2-18 (40) 2-19 (41), 2-20 (42), 2-21 (43), 2-22 (44)

SEA CHEST NUMBER 2

Transducer Identification Number	Type	Figure (Page)
1628	FS-1	1-5 (9), 1-7 (11), 2-1 (23), 2-11 (33) 2-42 (64), 2-43 (65)
1633	FS-1	1-5 (9), 1-7 (11)
1634	FS-1	1-5 (9), 1-7 (11), 2-2 (24), 2-10 (32), 2-44 (66), 2-45 (67)
1639	FS-1	1-5 (9), 1-7 (11)
1642	FS-1	1-5 (9), 1-7 (11), 2-46 (68), 2-47 (69)
1648	FS-1	1-5 (9), 1-7 (11)
1650A	FS-1	1-5 (9), 1-7 (11)
1653	FS-1	1-5 (9), 1-7 (11)
1654	FS-1	1-5 (9), 1-7 (11), 2-48 (70)
1657	FS-1	1-5 (9), 1-7 (11)
1660	FS-1	1-5 (9), 1-7 (11)
1665	FS-1	1-5 (9), 1-7 (11)
1667	FS-1	1-5 (9), 1-7 (11)
Stationary	GE	1-5 (9), 1-7 (11), 1-10 (14), 2-7 (29), 2-14 (36), 2-51 (73)
L1	GE-SEHG1	1-5 (9), 1-7 (11), 1-10 (14), 2-7 (29), 2-73 (94), 2-74 (95), 2-75 (96), 2-76 (97), 2-77 (98)
L2	GE-SEHG1	1-5 (9), 1-7 (11), 1-10 (14), 2-7 (29), 2-49 (71), 2-50 (72), 2-78 (99), 2-79 (100) 2-80 (101), 2-81 (102), 2-82 (103)
Move 1	GE	1-5 (9), 1-7 (11), 1-10 (14), 2-7 (29), 2-53 (74), 2-54 (75), 2-55 (76), 2-68 (89), 2-69 (90), 2-70 (91), 2-71 (92), 2-72 (93)
Move 2	GE	1-5 (9), 1-7 (11) 1-10 (14), 2-7 (29)
Move 3	GE	1-5 (9), 1-7 (11), 1-10 (14), 2-7 (29)
Move 4	GE	1-5 (9), 1-7 (11), 1-10 (14), 2-7 (29), 2-15 (37)

SEA CHEST NUMBER 2 (Cont'd)

Transducer Identification Number	Type	Figure (Page)
109	5E	1-5 (9), 1-7 (11)
110	5E	1-5 (9), 1-7 (11), 2-34 (56), 2-35 (57)
111	5E	1-5 (9), 1-7 (11), 2-36 (58), 2-37 (59), 2-38 (60), 2-39 (61)
116	5E	1-5 (9), 1-7 (11)
149	5E	1-5 (9), 1-7 (11), 2-40 (62), 2-41 (63)
43	5E	1-5 (9), 1-7 (11)

SEA CHEST NUMBER 3

Transducer Identification Number	Type	Figure (Page)
1621	FS-1	1-5 (9), 1-8 (12), 2-58 (79), 2-59 (80)
1619	FS-1	1-5 (9), 1-8 (12), 2-56 (77), 2-57 (78)
1624	FS-1	1-5 (9), 1-8 (12)
1626	FS-1	1-5 (9), 1-8 (12), 2-60 (81), 2-61 (82)
1645	FS-1	1-5 (9), 1-8 (12)
1646	FS-1	1-5 (9), 1-8 (12)
1649	FS-1	1-5 (9), 1-8 (12)
1650B	FS-1	1-5 (9), 1-8 (12), 2-4 (26), 2-16 (38), 2-64 (85), 2-65 (86)
1655	FS-1	1-5 (9), 1-8 (12), 2-3 (25), 2-17 (39), 2-62 (83), 2-63 (84)
1659	FS-1	1-5 (9), 1-8 (12), 2-66 (87), 2-67 (88)
1662	FS-1	1-5 (9), 1-8 (12)
1670	FS-1	1-5 (9), 1-8 (12)
1671	FS-1	1-5 (9), 1-8 (12)
112	AX-58	1-5 (9), 1-8 (12), 2-8 (30)

Sonar Dome

Transducer Identification Number	Type	Figure (Page)
27	DT-55	1-5 (9)
28	DT-55	1-5 (9)
55	DT-55	1-5 (9)